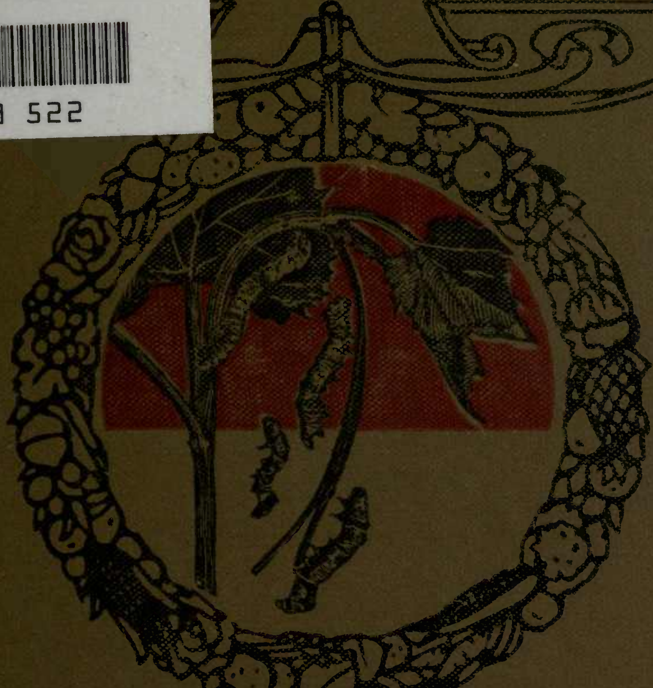
LIPPINCOTT'S FARM MANUALS



INJURIOUS INSECTS AND USEFUL BIRDS

BY F. L. WASHBURN M.A.

"The first farmer was the first man, and all historic nobility rests on possession and use of land."
—EMERSON.

LIPPINCOTT'S FARM MANUALS

EDITED BY

KARY C. DAVIS, PH. D. (CORNELL)

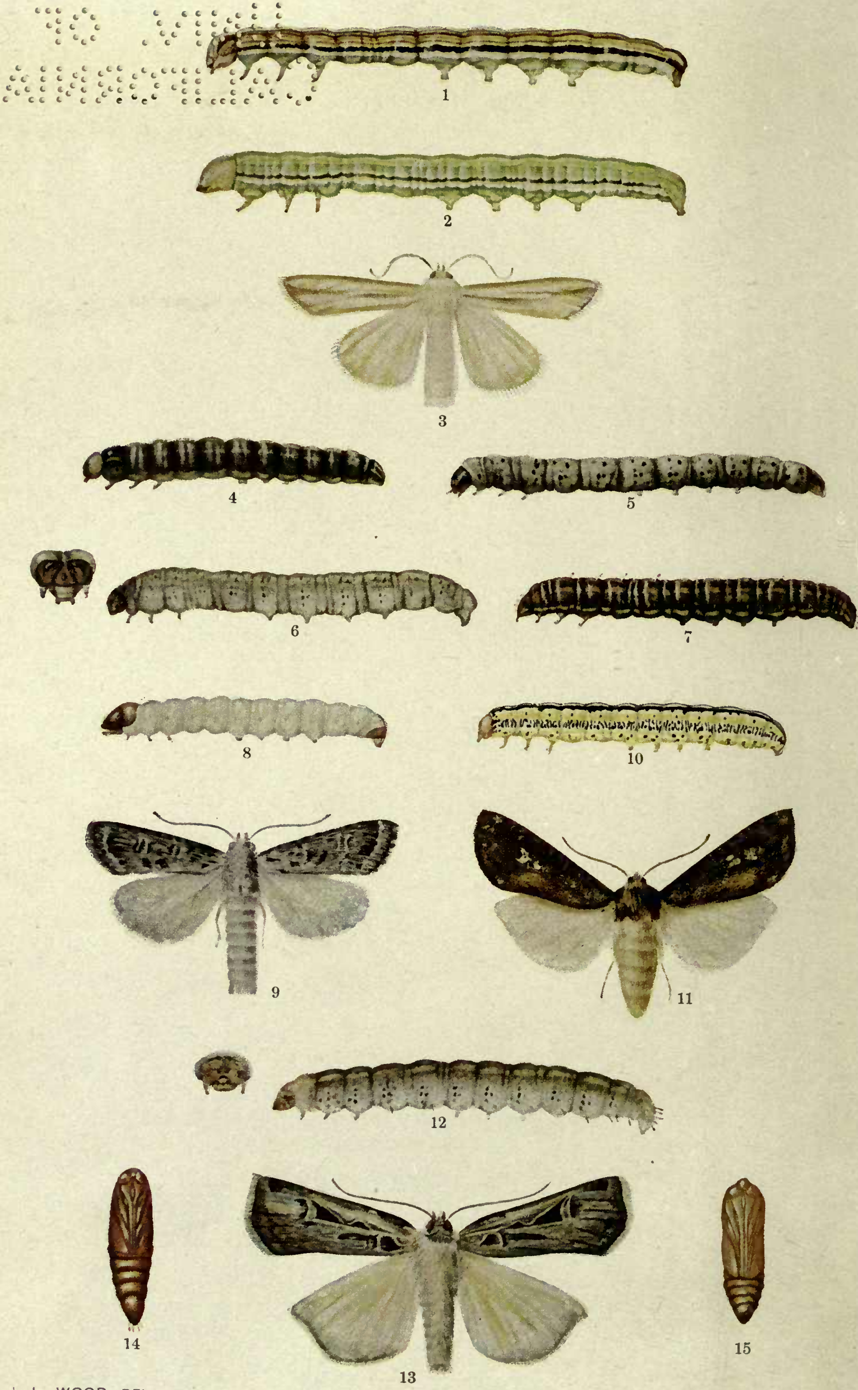
PROFESSOR OF AGRICULTURE, KNAPP SCHOOL OF COUNTRY LIFE GEORGE PEABODY COLLEGE FOR TEACHERS, NASHVILLE, TENNESSEE; AUTHOR OF PRODUCTIVE FARMING, ETC.

INJURIOUS INSECTS AND USEFUL BIRDS

SUCCESSFUL CONTROL OF FARM PESTS

BY F. L. WASHBURN, M.A. (HARVARD)

PROFESSOR OF ENTOMOLOGY, UNIVERSITY OF MINNESOTA; ENTOMOLOGIST TO THE MINNESOTA EXPERIMENT STATION, AND STATE ENTOMOLOGIST. FELLOW IN A. A. A. S., MEMBER OF AM. ASSOC. EC. ENT., AM. ENT. SOC., AM. SOC. OF NATURALISTS, ETC.



I. L. WOOD, DEL.

BUR. ENGRAVING, MPLS.

Plate 1. CUT WORMS, ARMY WORMS, AND OTHERS.

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BY

[illegible] M.A.

[illegible] ENTOMOLOGIST TO THE MINNESOTA [illegible]

[illegible]

[illegible] ILLUSTRATIONS IN TEXT
AND FOUR COLORED PLATES

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EXPLANATION OF PLATE I.

Figs. 1 and 2.—Wheat-head Army Worm (*M. albilinea* Hubn.), much enlarged, and showing variations in color.

Fig. 3.—Moth of the same.

Figs. 4, 5, 6, and 7.—Different Cut-worms, collected in the vicinity of St. Anthony Park, Minn.

Figs. 8, 9, and 15.—Caterpillar, Moth and Pupa of the Glassy Cut-worm (*Hadena devastatrix*).

Figs. 10 and 11.—The Zebra Caterpillar, or Painted Mamestra, and its Moth (*Mamestra picta* Harris).

Figs. 12, 13, and 14.—Larva, Moth and Pupa of the Cut-worm known as the Dingy Cut-worm (*Feltia jaculifera*).

On the left of figures 6 and 12 are front views of the corresponding cut-worms.

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*414 ILLUSTRATIONS IN TEXT
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PHILADELPHIA & LONDON
J. B. LIPPINCOTT COMPANY

Electrotyped and Printed by J. B. Lippincott Company
The Washington Square Press, Philadelphia, U. S. A.

TO
THE INSPIRING MEMORY
OF A
LOVING SISTER

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PREFACE

This book has been written in the hope of supplying the needs of high schools where Agriculture is taught, and of Agricultural Colleges which demand a good text-book that is not too technical, and where the work embraces a large field in which there is a call for practical information and suggestions. It is intended also to supply farmers, orchardists, vegetable growers, owners of gardens, and housekeepers with a reference book for guidance in a campaign against injurious insects and four-footed pests of the farm, and to assist them in obtaining information about some of our more common birds in their relation to agriculture. The widespread and growing interest in this latter group of animals is not to be disregarded.

The suggestions contained herein are largely the results of twenty-one years of work in Economic Entomology on the part of the author. Yet in so large a field one must of necessity have recourse to much experience not his own, and the author has not hesitated to obtain desired information from many reliable publications; such as bulletins and circulars from the United States Department of Agriculture, bulletins from the Geneva and the Cornell stations, and from all sections of the country.

Many illustrations are from Minnesota State publications. I have also been favored by the kindness of others who have loaned their cuts. Courtesies of this kind, which are hereby gratefully acknowledged, have been extended by the Bureau of Entomology, United States Department of Agriculture; P. J. Parrott, of the New York (Geneva) station; Dr. G. W. Herrick, of the Cornell station; the California station; Professor G. H. Dean, of Kansas; C. P. Gillette, of Colorado; R. A. Cooley, of Montana; W. C. O'Kane, of New Hampshire; H. A. Morgan, of Tennessee; W. E. Britton, of Connecticut; and the Ohio station. For figures 324 and 326 the author is indebted to the "Country Gentleman." Some illustrations of spraying apparatus were obtained from the Barnes Company and the Goulds Manufacturing Company. The J. B. Lippincott Company furnished some of the

originals for electrotypes, and have at all times given the author most courteous treatment. To the Macmillan Company, publishers of "The Citizen Bird," and the artist, L. A. Fuertes, the author is indebted for most of the excellent illustrations of birds. The three colored plates of birds and the colored plate of insects were made under my direction. I am much indebted to the editor for his painstaking effort in connection with this volume.

F. L. Washburn.

State Entomologist's Office,
University of Minnesota,
January, 1918.

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A hair line in connection with a figure indicates the natural size of the insect.

INJURIOUS INSECTS AND USEFUL BIRDS

CHAPTER I

LOSS TO AGRICULTURE DUE TO INSECTS AND RODENTS

INSECTS comprise fully four-fifths of the animal kingdom. Nearly 400,000 species have been named and described, and an enormous number, several millions, are probably in existence. Deciduous fruit interests lose, according to Quaintance, over $66,000,000 annually through the work of insects. The Mexican Cotton Boll Weevil in Texas alone has caused a loss of $25,000,000 annually, and when all southern states which produce cotton are infested with this insect, the country will lose $250,000,000 every year. In 1906 our hay crop was valued at $600,000,000, but might have been $60,000,000 more had it not been for the inroads made by insects. About $150,000,000 is sacrificed every year to the Hessian fly, and between the years 1894 and 1909 the chinch bug destroyed $350,000,000 worth of crop. The codling moth (Fig. 1) alone levies an annual tax in the United States of $12,000,000.

FIG. 1.—Codling moth, enlarged.

Farm and forest products (Fig. 2) each year in the United States probably average more than $8,000,000,000, and these same products suffer a loss annually of $900,000,000, approximately, through the attacks of insects. Of this the wheat crop alone suffers a loss each year of about $100,000,000. In 1908 a cut-worm, attacking corn over a limited area in Indiana, caused a loss to that crop of $200,000. The work of cattle ticks entails a loss of from $40,000,000 to $100,000,000 each year. Briefly, about ten per cent of all of our crops are sacrificed every year to insect ravages.

The work of the economic entomologists is to restore to the agricultural classes as much as possible of this loss, and, by their

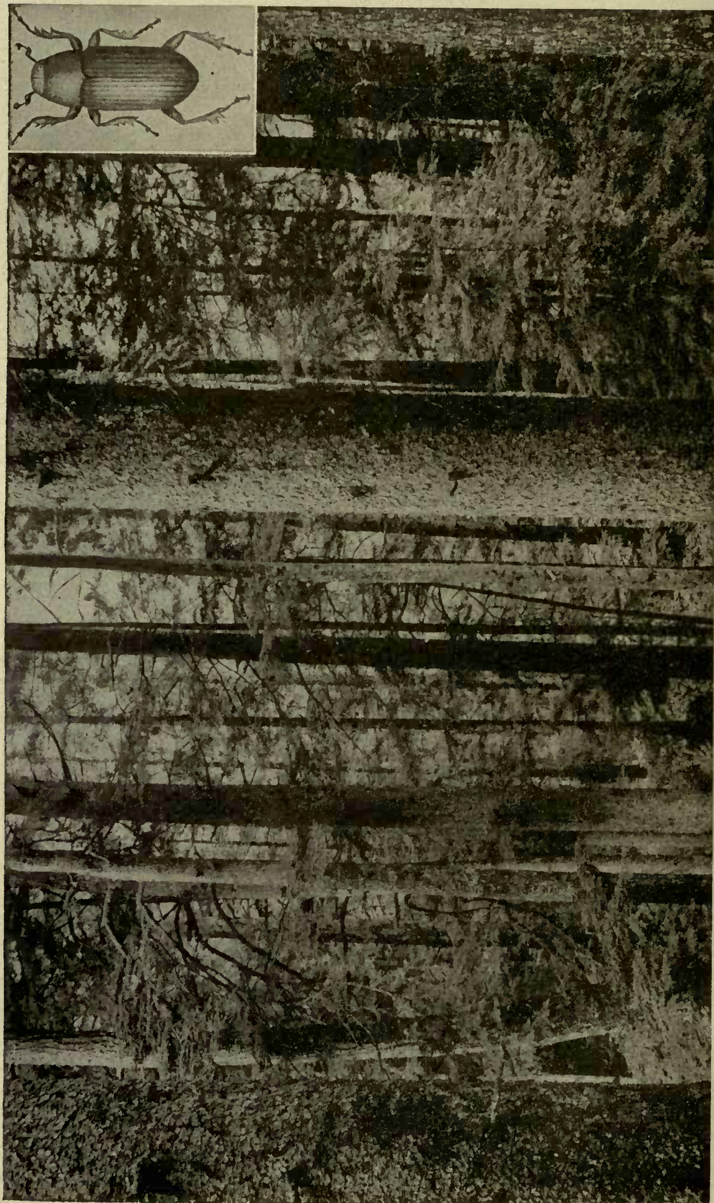


Fig. 2.—Our forests invite insect attack. In 1908 over two million feet of timber, it is claimed, had already been killed in the Black Hills Forest Reserve, by a single species of beetle, *Dendroctonus ponderosæ*. (Original.)

researches, to place citizens on their guard against insect enemies. That their work is appreciated is shown by the large appropriations for this work made by federal and state governments. Massachusetts, for example, has used, in the past, $150,000 annually to combat the gipsy moth, to which must be added approximately $100,000 spent by private citizens in that state and $10,000 con-

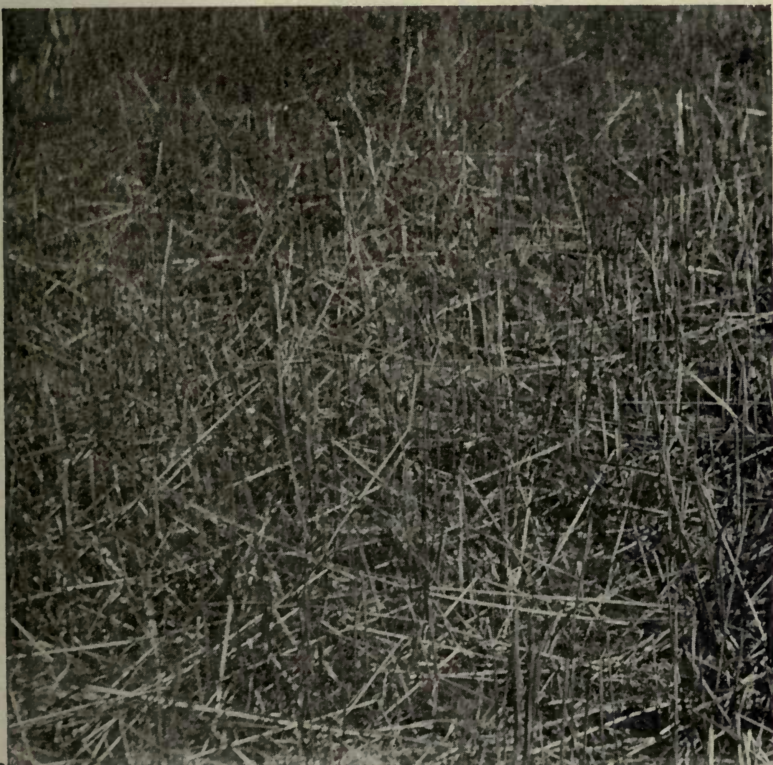


FIG. 3.—A portion of a wheat field badly "down" as a result of the work of the Hessian fly (Original.)

tributed by the United States Government. New Jersey is on record as spending $350,000 a year in fighting mosquitoes alone. Losses from the San José scale, codling moth, Hessian fly (see Fig. 3), chinch bugs, and grasshoppers have been materially reduced through the work of our entomologists, who have also lessened by nearly or quite half the $100,000,000 loss on stored

products, such as mill stuffs, fruit, cotton, woollens, etc., suffered each year in the United States.

Squirrels, gophers, and prairie dogs destroy every year something like $10,000,000 worth of agricultural products. In the winter of 1901–1902 nurserymen near Rochester, New York, sustained a loss of $100,000 through the work of field mice. In the case of prairie dogs, conservative estimates place the annual loss in Nebraska, due to this rodent, at $80,000, and ground squirrels in one ranch in Nevada, in one season, caused a loss to the grain crop of $10,000.

QUESTIONS

1. What losses have been sustained by farmers in your neighborhood, caused by grain insects?
2. What injury have you seen done to trees by insects?
3. Are there any valuable forest areas in your state?
4. Have they been injured by insect pests?
5. What is your state doing to protect its forest areas?
6. What orchard insects are troublesome in your vicinity and what is being done to combat them?

CHAPTER II

FARM PRACTICES TO LESSEN INSECT AND RODENT INJURIES

Modern methods in farming have much to do with the control of farm pests. Fall plowing and the use of tooth and disk harrows are helpful in destroying or exposing to their enemies such insects as pass the winter in the ground. In parts of the country where it is practical, summer fallowing, by keeping down all weeds, starves out insects which normally would feed upon them.

Cleaning Up in Autumn.—Corn shocks afford hibernating quarters (Fig. 4) for chinch bugs and field mice; and cabbage and

Fig. 4.—Shocks of corn left in the field over winter afford shelters for chinch bugs and field mice.

cauliflower stalks—melancholy objects in the field—harbor the pupæ of cabbage maggots over winter; old melon and cucumber vines may afford retreats for insects infesting cucurbits, and volunteer plants and weeds, both along fence rows (Fig. 5) and in other places, add to the number of Hessian flies, chinch bugs, joint worms, field mice and other pests. Clean farming, therefore, which means the cleaning up and destruction by burning of this rubbish, should be the rule. A neglected orchard is a breeding place for scale and borers; broken branches, dead or dying, invite the presence of hosts of minute beetles which bore in bark and wood (see Fig. 6).

The modern orchardist does not permit these things to exist, and in his orchard there is to be found no tangle of matted grass to afford a hibernating place for mice and countless insects. Intelligent pruning will not only shape a tree, but the burning of the branches cut will destroy many eggs of aphids and of other insects.

Systematic spraying of trees with the proper compounds is a necessity for one who would produce marketable fruit, and frequently protects an orchard, not only against insects which eat the leaf and fruit, but against other pests as well (Fig. 7).

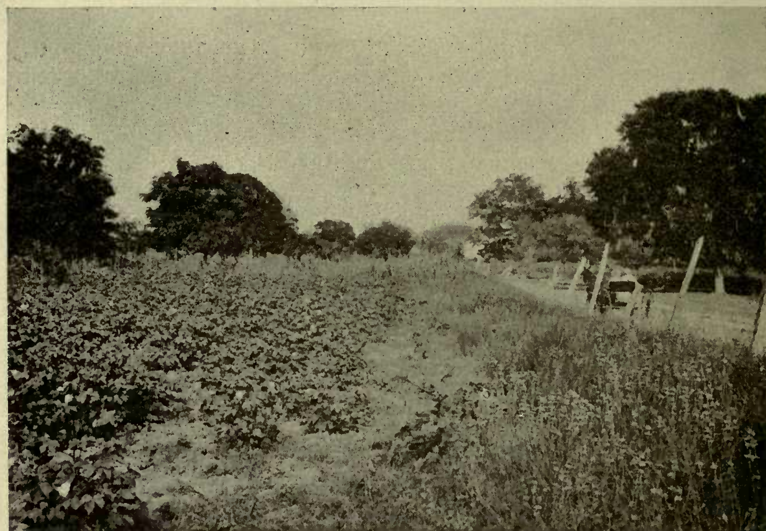


FIG. 5.—A weedy fence row harbors many insect pests. (Bull. 77, U. S. Bu. Ent.)

Early mulching of trees or of any crop should be avoided, for field mice that work all winter look, in the fall, before freezing occurs, for snug nesting places for the winter.

A field of timothy which has been in sod for a number of years is likely to become infested with army worms. Intelligent rotation, therefore, is practiced to-day by the wide-awake farmer, care being taken not to follow one crop with another equally as attractive to the insect he seeks to exterminate.

Sod land is the natural abode of wire worms and cut-worms, and corn or grain or some truck crops following sod are likely to be injured.

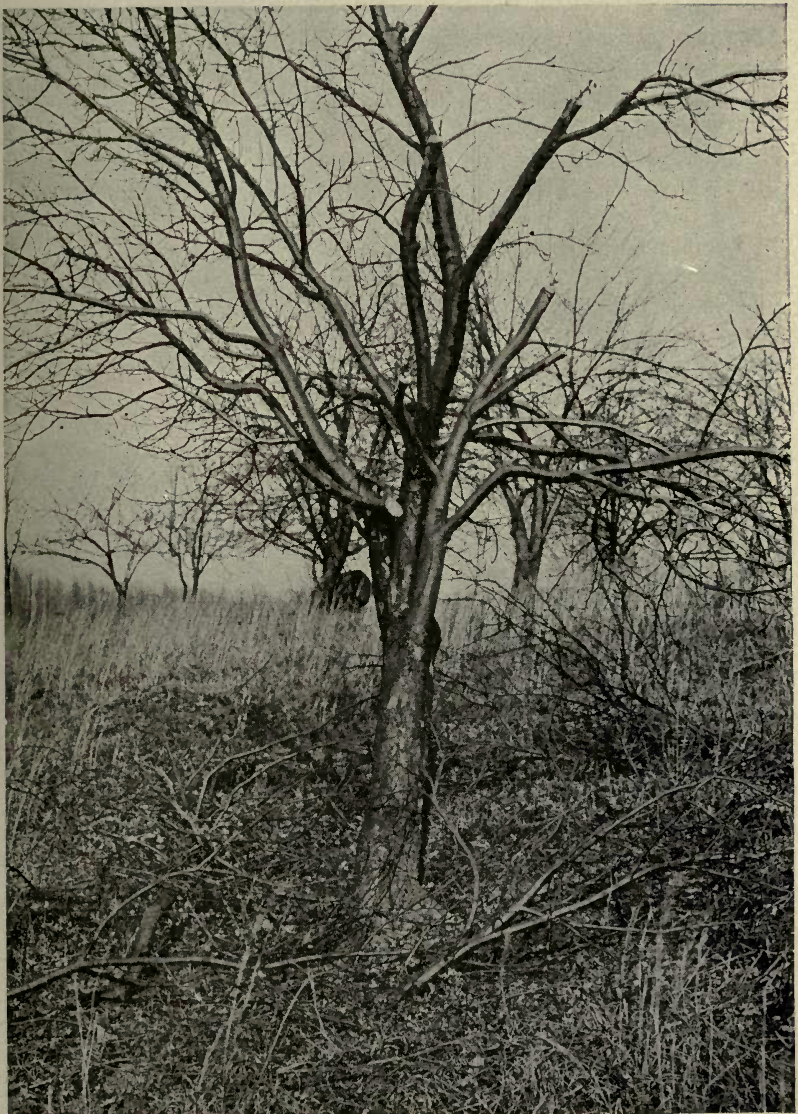


FIG. 6.—Branches left lying on the ground under a top-worked tree. The fruit tree bark beetles breed in these branches. (After Brooks, U. S. Bu. Ent.)

Early or late planting of certain crops may result in these escaping injury; for example, from the cotton boll worm, Hessian fly and others. The early cutting of clover leaves the second crop less subject to injury from the Clover-seed chalcid.

Heavy fertilization or intensive cultivation, or both, may so force a crop as to enable it to outgrow insect injury.

Resistant Plants.—The grower may also buy resistant stock—fruit trees on roots resistant to borers—or he may plant strong stemmed wheat which will not readily break as the result of Hessian fly injury. Occasionally a choice in varieties will help, as in the case of the strawberry weevil, which attacks only staminate varieties of berries.

FIG. 7.—Portion of an orchard showing trees well covered with a dormant spray. (Dean, in Kansas Bull.)

Protection of all birds known to be useful, and judicious treatment of those thought to be injurious should be the program of a wide-awake farmer, and one should be cautious in condemning any bird, since an injurious trait may be a temporary one, due to unusual conditions, and may be more than balanced by a bird's good qualities exercised at another season. One should, in particular, hold the right attitude toward hawks and owls—a group formerly regarded with unjust suspicion. With the exception of Coopers Hawk, and at times other large hawks regarded as "hen hawks," and the sharp-shinned hawk which feeds largely on small birds, all of the hawks and owls are more or less useful, some of them decidedly so, since they feed upon insects, field mice, gophers, rabbits and ground squirrels (see Chapter XX).

It is believed that the large increase in field mice in parts of the Middle West may be accounted for very largely by the war of destruction waged against hawks and owls, and animals such as

the common skunk, weasels, and foxes. The natural food of the skunk is not chickens or eggs, but insects, mice, and young rabbits. A weasel, having acquired the habit, may at times kill poultry; yet normally they eat meadow mice, rabbits, and squirrels. Foxes—occasional depredators—cannot injure chickens which are properly housed at night. In the open, they feed upon rabbits, chipmunks, field mice, crickets, grasshoppers, white grubs, and May beetles. The ruffed grouse and the quail, also, suffer through their attacks.

Hogs in an orchard pick up wormy windfalls; and hogs or sheep, or both, turned into an insect-infested field after crops are removed, are helps to the orchardist and agriculturist. Neglect of active measures at the beginning of an attack frequently means loss; plant lice, for example, increase with marvellous rapidity, and individuals should be destroyed by thorough treatment at the very beginning of their work.

Certain questions, however, should present themselves to the thoughtful farmer or orchardist before attacking an insect which is apparently causing him a loss. He should first of all ask himself whether the insect in question is really the cause of the injury observed; secondly, is its attack lasting, thus making it necessary to take action, or is it temporary and not of great importance? thirdly, is the insect subject to attacks from birds or predaceous or parasitic insects (not always readily determined) which will make it unnecessary for one to wage war upon it? and, finally, if its extermination is practical, which is the best and most economical way to attack it?—is it a sucking insect or one which eats the surface of the plant? If it is a sucking insect, employment of internal poisons, like arsenic, Paris green or arsenate of lead, would be absolutely useless.

Stop Rodents in Time.—One pocket gopher, in a nursery or young orchard, may, by working on roots, put many trees out of commission. This can be prevented by early attention. Mice and rabbits, in situations subject to their presence, will in winter work havoc on unprotected young apple trees.

Coöperation.—Finally, there should exist in a farm community a spirit of coöperation in up-to-date farming methods and in general protection which spells success in agriculture. One farmer's effort against grasshoppers or Hessian flies is of little avail if his neighbors are not equally active. A striving to attain a certain high standard of excellence on the part of all members of

a farming community should replace efforts on the part of individuals to excel their neighbors. Attention to the precept of general helpfulness means success for every individual.

QUESTIONS

1. Discuss, in general, modern methods of farming which tend to discourage the activities of insect pests and injurious rodents.
2. What points in farm practice are to be avoided by an up-to-date farmer?
3. What relation to the farmers' interests is borne by skunks, owls, hawks?
4. What questions would naturally present themselves to a farmer before taking action against an insect?
5. Discuss the value of coöperation among farmers as it applies to fighting insect pests.

CHAPTER III

EXTERNAL STRUCTURE OF INSECTS; ORDERS; METAMORPHOSIS

ONE Branch or Phylum of the animal kingdom is called *Arthropoda* ("jointed-footed") and includes all animals without a backbone, which have segmented bodies, some or all of the body segments bearing jointed appendages of various kinds. Some of these animals live in water or moist places, are covered with a shelly crust, and are called *Crustacea*—the crayfish, lobster and crab, and barnacles, for example.

Most of the other sub-groups under this Phylum live on land, when adult. But some are worm-like, with many legs, the centipedes and millipeds, class *Myriapoda;* and some have the head and thorax (second division of the body) in one piece, and have in the adult stage eight legs. This group includes the scorpions, mites, ticks, and spiders.

The Class Insecta or Hexapoda ("six-legged") includes all the insects, and if we were asked to give in a brief way the characteristics which would include all insects, and exclude all other animals, we would say:

Insects are Arthropods, which in the adult stage have six legs and no more: they breathe air directly through a system of tubes (tracheæ) opening on the surface. In their life history they pass through, from the egg stage to the adult, more or less changes or metamorphoses: they have one pair of antennæ (feelers), two compound eyes, and frequently one or more simple eyes. They generally have wings in the adult stage (Fig. 8).

Differences among Insects.—It will be seen from the above that neither a spider nor a tick is an insect. In looking over this enormous class, comprising at least four-fifths of all known species of animals, we note that there are some great differences between them; a squash bug is widely different from a butterfly, though agreeing with it in the above general characteristics, and a beetle does not resemble a mosquito. Hence the class is divided into a number of groups called Orders (see page 14). These Orders are largely characterized by differences in mouth parts and in the nature and number of the wings when present. The mouth parts

in the typical insect, intended for biting, may be modified to form a sucking apparatus, the maxillæ and mandibles being lengthened and frequently enclosed in a sheath formed by the labium.

The stages of an insect's life are commonly the egg stage, the larval stage, the pupal or resting stage, and the adult or imago. In insects without a complete metamorphosis, the larval and pupal stages are both active, and frequently referred to as the nymphal stage, or "the nymph." All growth during an insect's life occurs in the larval or nymph stage, and is accompanied by several moultings of the larval skin. Each moult is called an "ecdysis."

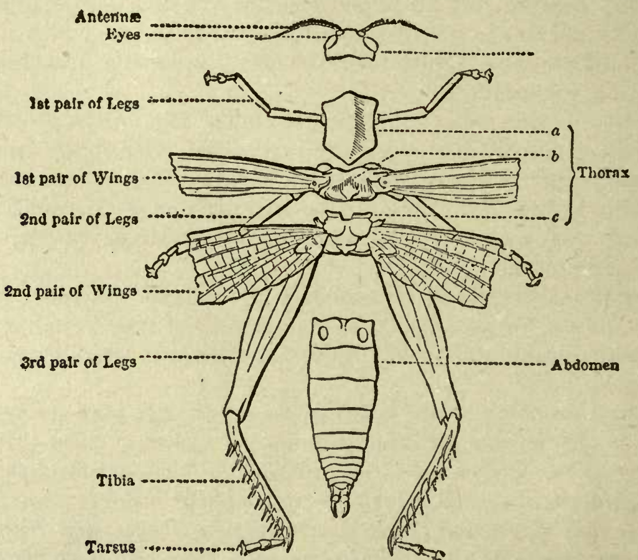


FIG. 8.—Dissection of a locust or grasshopper to show divisions of the body.

The parts of a typical insect consist of a head, thorax, and abdomen.

The head bears antennæ, a pair of large compound eyes (see Figs. 8 and 9), and a few simple eyes. On the under side of the head occur the mouth parts, viz., the *labrum*, then a pair of strong *mandibles;* following these a pair of *maxillæ*, each with palp attached, and lastly the *labium* and labial palps. These typical structures are, as intimated above, modified in some of the orders; in fact, they are to a certain extent the fundamental cause of some of the groups given below. These variations adapt the possessors

to their different modes of life. In the sucking forms, such as mosquitoes and squash bugs, the insects suck the blood of animals or the juice of plants, piercing the surface with the mouth parts.

The thorax or middle part of a typical insect's body really consists of three sub-parts: the *prothorax*, bearing the front pair of legs; the *mesothorax*, bearing the front pair of wings and second pair of legs, and the *metathorax*, from which spring the hind pair of legs and posterior pair of wings (Fig. 8).

The leg of a typical insect consists of the following joints: a small globular joint next to the body called *coxa*, then a long joint, generally the larger, called the *femur*,* then a slender, long joint known as the *tibia*, and finally the *tarsus*, consisting typically of five joints, the last bearing two tiny claws. Between these claws is a pad-like appendage called the *pulvillus* (Fig. 10).

FIG. 9.—Surface view of the facets of a compound eye, much enlarged.

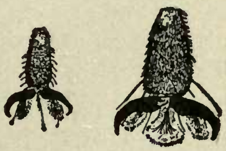


FIG. 10.—Two types of the last tarsal joint. The pulvillus in figure on right is pad-like; in the figure on left it is represented by a bristle.

The abdomen.—Behind the thorax is the abdomen of a varying number of segments. On the sides of the abdomen and the sides of the thorax occur the spiracles, openings leading into the tracheal system through which the adult insect obtains its supply of oxygen. It is to be noted, however, that insects will live a long time without oxygen. The posterior end of the abdomen may exhibit appendages, notably the ovipositor in the female grasshopper or the sting (modified ovipositor) in wasps or worker bees.

The hard, outer part of an insect's body (called exoskeleton) is composed of a horny substance, called *chitin*.

Special Senses.—The sense of sight in insects is probably very primitive, as are also the other special senses. The sense of *hearing* exists in pits in the antennæ, or in special organs on the first segment of the abdomen, or in the *tibiæ* of some *Orthoptera*. That insects can hear is evidenced by the fact that we find sound-producing mechanisms, which would not exist unless there also existed the means of hearing the same. The sense of *smell* is located in olfac-

*A very small segment, sometimes well marked, between coxa and femur, is called the *trochanter*.

tory pits in and on papillæ or the antennæ. The function of *taste* is located in some of the mouth parts, and minute hairs on the body are connected with nerve endings within and form part of a mechanism affording a delicate sense of feeling. The sense of *touch* is doubtless most highly developed in the antennæ, hence these are often called the "feelers."

Reproduction in Insects.—The two primary forces directing animal life are the need of nutrition and the instinct of reproduction. Normally we find among insects, as in many other animals, mating and egg-laying, the egg hatching and producing the *larva* which later gives rise to the *pupa.*

Agamic Reproduction.—In a few forms, however, notably among the plant lice, we have agamic reproduction, that is, several generations produced without mating, and the phenomenon is so striking and at such variance to the rule that we give here a brief outline of reproduction of plant lice, which, in a general way, is similar in practically all of the genera.

From an egg which has passed the winter on the favorite food plant of a species, there hatches in the spring a female called the "stem-mother." This insect in a few days gives birth directly to other females; each one in its turn does the same, averaging five or six young a day for several days before the mother's activity is ended by death. This process, known as *parthenogenesis,* endures throughout the summer. During the summer and particularly towards fall winged females are born called "migrants," who fly to other parts of the tree or plant, or to other trees and plants, and start new colonies. In the fall, true sexual males and females appear, mate, and the eggs are laid which produce the stem-mothers in the following spring. The enormous number of descendants resulting in the autumn from even the one stem-mother can be estimated approximately, and one can readily realize how destructive plant lice may be and how difficult to exterminate.

ORDERS OF INSECTS

As already stated, the class *Insecta* is divided into a number of main divisions called orders. Entomologists recognize nineteen of the main orders, besides several sub-orders. These orders are here briefly described.

Order Thysanura.—Wingless insects without metamorphosis, the larval form being retained by the adult. True compound eyes rarely present. Examples, fish moth and spring tails—the former

(Fig. 11) a household pest, and the latter minute and occurring in swarms in moist situations.

Order Ephemerida.—This includes the delicate May flies so abundant in spring and early summer. They have four delicate wings, and live but a short time as adults. The young stage, nymph, is found in the water (Fig. 12).

Order Neuroptera.—This group is characterized by the presence of four delicately veined wings. Representatives of the order are the Golden-eyed Lace-winged fly, whose larva consumes plant

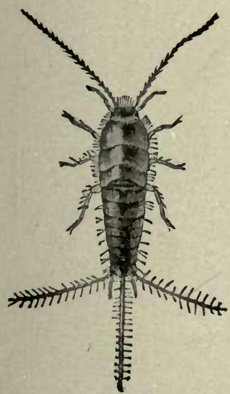


Fig. 11.—A "silver fish" or "fish moth."

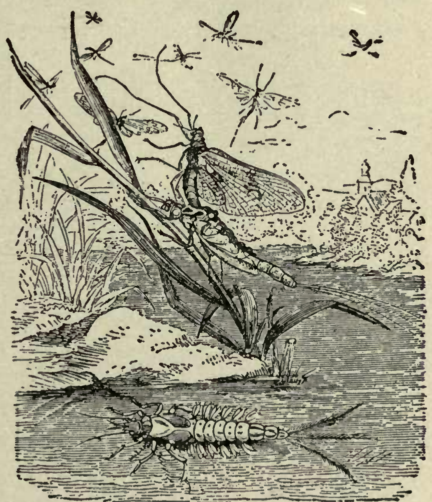


Fig. 12.— May-flies. Nymph and imago in foreground.

lice, and the "ant-lion," whose larva digs pits in sandy soil, wherein it lies in wait for other insects (Fig. 13).

Order Mecoptera.—A very small group containing the scorpion flies.

Order Trichoptera.—Caddis-flies or Caddis-worms. Four-winged with a complete metamorphosis. The larvæ construct cases of sand, gravel, and frequently of leaves, etc. In these cases they pass their larval life, crawling about on the beds or bottoms of streams. The mouth parts of the adult are rudimentary (Fig. 14).

Order Odonata.—The *dragon flies* and *damsel flies*, with four wings of nearly equal size, biting mouth parts, and large compound

eyes. The metamorphosis is incomplete. The larval or nymph stage is passed in the water (Fig. 15).

Order Plecoptera.—Insects with four membranous wings, hind

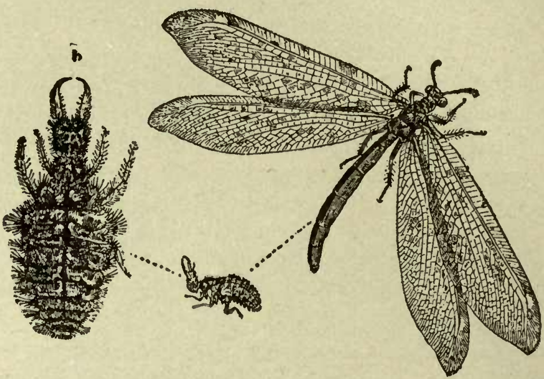


Fig. 13.—Ant-lion with larva, enlarged and natural size.

wings much larger than fore wings, and when not in use folded in plaits. Wings lie flat upon the abdomen when the insect is at rest. Biting mouth parts frequently poorly developed. Metamorphosis incomplete, nymphs living in water. Example, *stone flies.*

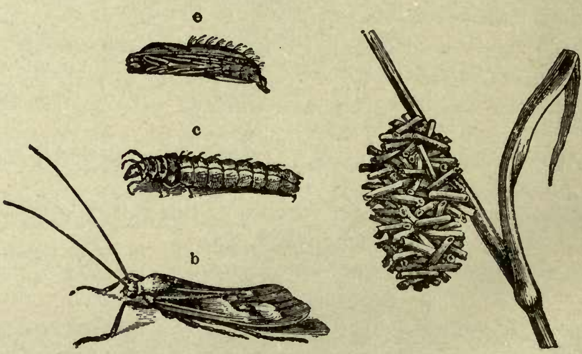


Fig. 14.—A caddis-fly, showing *c*, larva, removed from its case; *b*, adult; *e*, pupa. On the right is a case made of stems.

Order Isoptera.—Social insects, colonies including queens, kings, and workers, only the first two casts being winged, and then only temporarily. Mouth parts formed for biting; incomplete

metamorphosis. Example, white ants or termites (these must not be confused with true ants).

Order Corrodentia.—Small four-winged insects; biting mouth parts; incomplete metamorphosis. Winged species feed upon lichens. A well-known wingless form is the tiny book louse.

Order Mallophaga.—The so-called bird lice (not true lice, which are sucking insects), feeding upon feathers on birds and fur on mammals; wingless parasites with biting mouth parts; metamorphosis incomplete.

Order Euplexoptera.—Earwigs found in the South and on the Pacific Coast; rare in northeastern United States. The name ear-

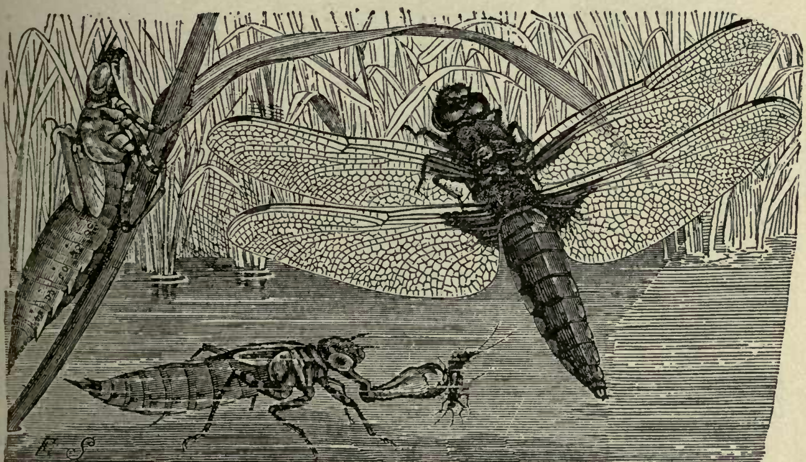


Fig. 15.—Dragon fly: below, nymph; on left, pupal skin.

wig is given them because of a popular and erroneous belief that they creep into the ears of people when asleep. The wings are rudimentary. Posteriorly the abdomen has a pair of appendages resembling forceps. The metamorphosis is incomplete (Figs. 16 and 17).

Order Thysanoptera.—(Thrips.) Minute four-winged insects. Many are especially injurious to agriculture. The mouth parts are evidently used for sucking. The metamorphosis is incomplete. Some species can be found by pulling apart blossoms of clover or daisies (Fig. 18).

Order Orthoptera (**"straight-winged"**).—Here occur the

locusts, which we commonly call grasshoppers (Fig. 19), the true grasshoppers (Fig. 20), and katydids (Fig. 21); crickets, "walking-sticks" (Fig. 22), and cockroaches. These insects have, for the most part, four wings, the foremost pair being really wing covers, or *tegmina*; the second pair are thin and gauzy, the mouth parts are formed for biting, and the metamorphosis is incomplete. The

Fig. 16.—Earwig with wings expanded.

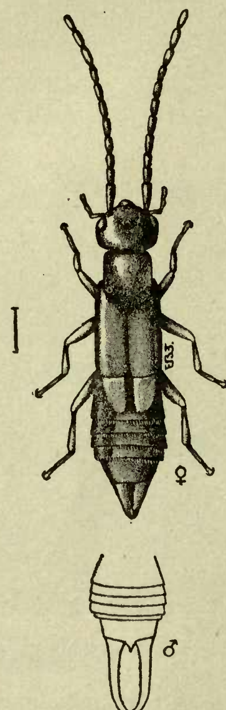


Fig. 17.—Upper figure, female earwig; below, end of abdomen of male, showing appendages. Both much enlarged.

Fig. 18.—A specimen of thrips.

grasshoppers, locusts, crickets and katydids have hind legs adapted for jumping. This order is at times very injurious; the Rocky Mountain locust or grasshopper, which normally lays its eggs on the slopes of the Rockies, frequently breeds on the plains east of there, and has at times swept down upon portions of Kansas, Nebraska, Dakota, Minnesota and other states, leaving no living

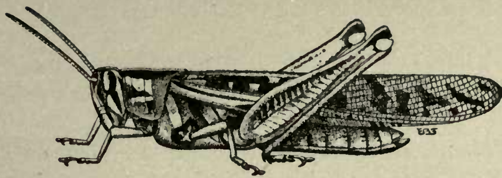


Fig. 19.—A locust, commonly called grasshopper.

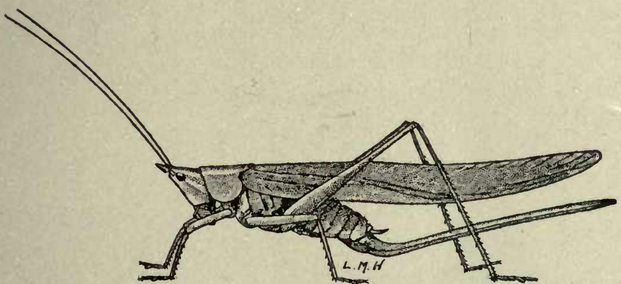


Fig. 20.—A true grasshopper.

Fig. 21.—A katydid laying eggs.

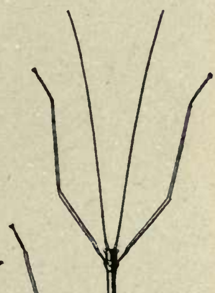


Fig. 22.—A walking-stick.

plant behind it. Locusts and grasshoppers lay their eggs in the soil, and fall plowing generally serves to keep our native forms in check.

Order Coleoptera ("sheath-winged").—This name refers to the fact that the insects of this group have the fore wings hardened and horny, or modified to form covers for the second pair of wings, the true wings, when they are present. They have biting mouth parts, and a complete metamorphosis. The group includes the beetles. The potato beetle ("potato bug"), most of our wood borers, the May beetle which comes from the white grub, blister beetles, plum curculio, weevils, and many others occur here (Figs. 23 and 24).

Fig. 23.—A ground beetle.

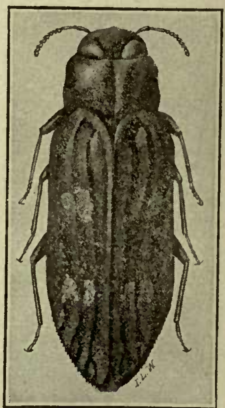


Fig. 24.—A buprestid beetle.

Order Hymenoptera ("membrane-winged").—Members of this group of insects have four membranous wings with but few veins therein. The front wings are the larger. Mouth parts adapted for biting and sucking. The abdomen of the female is usually fur-

nished with a sting, piercer or "saw." The metamorphosis is complete (Fig. 25).

The honey-bee is a good example of this order, which also includes the true ants, the wasps, hornets, and sawflies. A large number of parasites which attack injurious forms of insects are also found here.

Order Hemiptera.—This order includes all the plant lice, the true parasitic lice, all the scale insects, and the true bugs (Fig. 26). The name *Hemiptera*, which means "half-winged," is given the entire order because the anterior half of the first pair of wings in

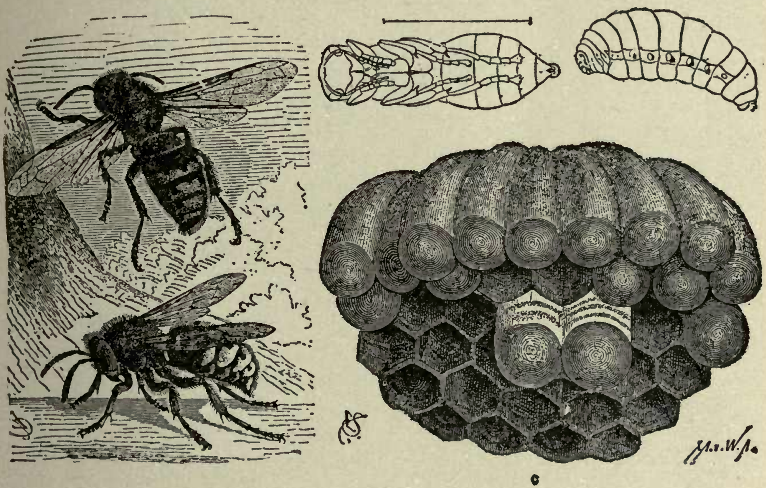


Fig. 25.—Hornets, with larva, pupa and cells.

the true bugs is thickened, only the posterior part being wing-like. The mouth parts are formed for sucking, and they have an incomplete metamorphosis. This is probably our most destructive order, for here occur scale insects, plant lice, leaf hoppers and tree hoppers, squash bugs, Cicadids or harvest flies, and the true lice which affect man and animals. It is interesting to note that the word "bug," which is frequently employed to designate any insect, is rightfully applied only to that division of the *Hemiptera* which are "half-winged," sub-order *Heteroptera*.

Sub-order Homoptera.—Scale insects, plant lice and mealy bugs belong to the sub-order *Homoptera*. At some stage these have gauze-like wings.

Order Diptera ("two-winged").—These are the true flies, such as the house-fly, mosquito, horse flies, etc., characterized by the possession of only two wings, the second pair being represented by a pair of small knobbed projections, the halteres or balancers; they have mouth parts adapted for sucking, lapping or stabbing. They have a complete metamorphosis, the larva being referred to as a "maggot," and the pupa or resting stage is enclosed in a brown skin called *puparium*. Figure 27 illustrates a type of the order.

Order Siphonaptera.—These are wingless, degraded insects, with no compound eyes, but having a complete metamorphosis. The mouth parts are adapted for sucking. Here occur the dog and cat flea, human flea, and others.

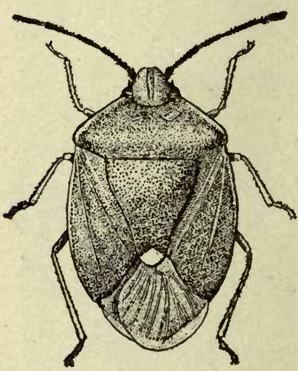


Fig. 26.—A true bug.

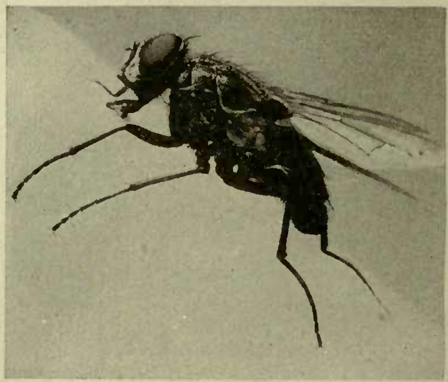


Fig. 27.—House-fly on lump of sugar. (After Brues.)

Order Lepidoptera ("scale-winged").—The butterflies, moths and skippers are characterized by the presence of four wings, covered with tiny scales which easily rub off if the insect is handled roughly. To these minute scales is due the color of the wings. The mouth parts of these insects are modified for sucking. They have a complete metamorphosis. The larva is spoken of as a "caterpillar," and tent caterpillars and cut-worms are familiar objects in the country. Caterpillars have six true legs, and a varying number of temporary fleshy projections called "pro-legs," or "prop-legs." The moths are generally, but not always, night fliers; their antennæ are usually either thread-like or feather-like. When at rest they rarely hold their wings elevated as do butterflies. The skippers are day fliers, and dart rapidly from place to

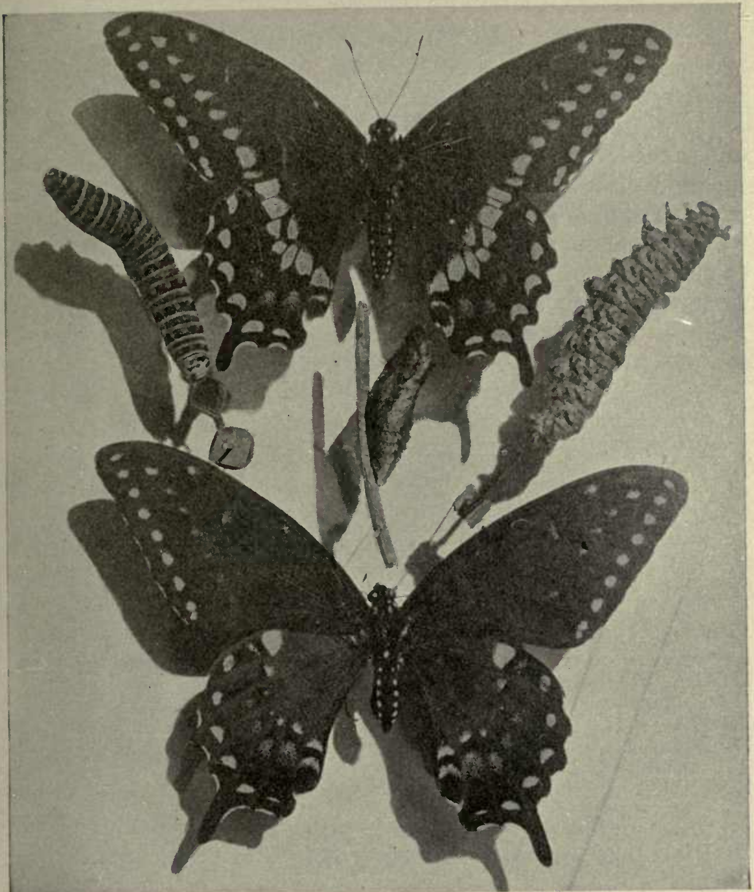


Fig. 28.—The parsley butterfly, male above, female below; caterpillars also shown.

Fig. 29.—A small moth.

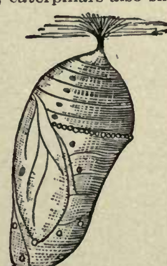


Fig. 30.—A chrysalis. (After Riley.)

place. Butterflies (Fig. 28) are day fliers; their antennæ or feelers are thread-like, with a knob on the end. Injurious forms in this order are the codling moth (Fig. 29), currant borer, cut-worms, army worm, and others. The pupal stage of butterflies is naked and called a "chrysalis" (Fig. 30). The pupa of a moth is inclosed either in a silken cocoon or in a cell below the surface of the ground.

Other Groups.—Insects in an order are divided into *families;* each family is divided into *genera;* each genus into *species,* and we frequently have *varieties* of a species. These groups and sub-groups are used in classification.

QUESTIONS

1. What is the place of insects in the animal kingdom?
2. Give a comprehensive definition of an insect.
3. Name the three parts of an insect's body. Does each part bear appendages?
4. Name mouth parts of typical insects in order of their occurrence, beginning with the most anterior.
5. Are they the same in all insects?
6. What are the parts of an insect's leg?
7. Are all of the legs alike in the grasshopper?
8. Compare the legs of a caterpillar with those of a moth or butterfly, which produces the caterpillar.
9. What is meant by a "pro-leg" or a "prop-leg"?
10. What insects fly? Name a few which never fly. Do beetles fly?
11. Give, in general, the life history of a butterfly.
12. Of plant lice.
13. Name the orders of insects and give example or examples under each order.
14. Describe complete and incomplete metamorphosis in insects. Give examples.
15. What is the difference between the pupal stage of a moth and that of a butterfly?
16. How does an insect see, feel, smell, and hear?
17. Name, in proper order, the divisions and sub-divisions used in classifying insects.

CHAPTER IV

COLLECTING AND PRESERVING INSECTS

THE young collector has probably provided himself or herself with some insect pins and some sheet cork, which can be purchased for a small sum from retail dealers, though he can substitute slices of cork stoppers for his sheet cork, or pith from corn stalks, or corrugated paste-board packing, at no expense whatever, gluing the same to the bottom of a cigar box. Good insect pins of various sizes he can hardly get along without if he purposes to pin his specimens. The late spring and summer months naturally offer the best opportunities for collecting.

When he goes into the field he should take a good insect net, one or two cyanide bottles, a few vials for holding delicate insects (some vials half full of alcohol for killing larvæ), and some paper pill boxes, or tin salve boxes. These and the vials will hold living larvæ, which the collector may desire to take home. A pair of

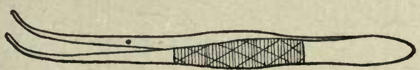


FIG. 31.—Small forceps.

forceps (Fig. 31) is not necessary, but sometimes very convenient in handling very small insects and those that sting. A box (cigar box will do) and some envelopes or folded papers are desirable to safely hold butterflies with wings folded until the return home.

A cyanide bottle (Fig. 32) is made by placing two or three small pieces of cyanide of potassium,* pieces to be a little bigger than peas, or one large piece, in the bottom of a large-mouthed vial, and covering the same with plaster of Paris, to which water has first been added. This mixture should be of such consistency that it will just pour into the bottle, covering the cyanide half an inch. Leave the bottle open for a few hours until the plaster is set. If liquid gathers on the top of the plaster, dust in more dry plaster, and later a piece of blotting paper can be placed over the plaster to absorb moisture, and occasionally removed. As cyanide of potash is deadly poison, it is well to put the word "POISON" on the bottle. A tight cork should be provided, and care should

* Or sodium cyanide, if easier to obtain.

be taken not to leave the bottle open, after it is in use, for any length of time, lest it should lose its strength. A very useful style of bottle is shown in figure 33. This is provided at one end with a metal cap, which can be removed, and either cyanide or chloroform placed on cotton in the lower end. A small straight-side vial made into a cyanide bottle is useful for very small insects, and takes up but little room in the pocket. In fact, one should take more than one cyanide bottle into the field to forestall any accident which might befall one, and to have one to use before insects are

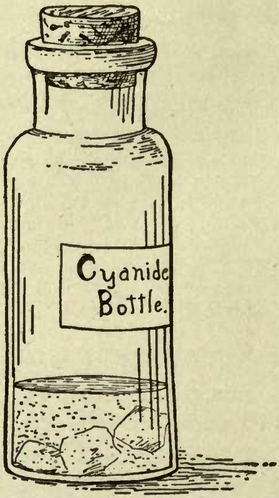


FIG. 32.—Home-made cyanide bottle.

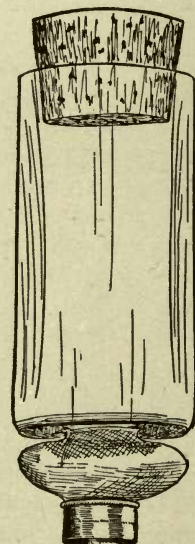


FIG. 33.—A more elaborate killing bottle.

dead in the other. It is well to leave specimens, except delicate moths, over night in the cyanide bottle, or at least for several hours. Strips of paper in a cyanide bottle prevent undue rattling about of insects, and serve to absorb injurious moisture.

A serviceable net can be made out of mosquito bar (or, better, of bobbinet), strung on a wire hoop fastened to a pole about five feet long. It is a very good plan to fasten a narrow strip of cloth to the wire hoop, and sew the net to that. Better nets and jointed poles can be purchased. Figure 34 shows a folding net, which can be packed in a small space. One may prefer a net which tapers

considerably, but not to a point. Some insects are best caught when they are on the wing; others should be allowed to alight. A quick pass is made with the net, forcing the butterfly or moth, or grasshopper, as the case may be, to the bottom, and a turn of the wrist folds the net upon itself, preventing the captive from escaping. In sweeping for grass or clover insects, the net is passed back and forth as one walks along, striking the tops of the plants, and by its continued and rapid motion the captured specimens are kept safely in the bottom of the net until the collector stops, when a rapid turn doubles the net and holds all the contained insects securely. In beating brush or shrubbery a "beating net," made of stout cloth, is used.

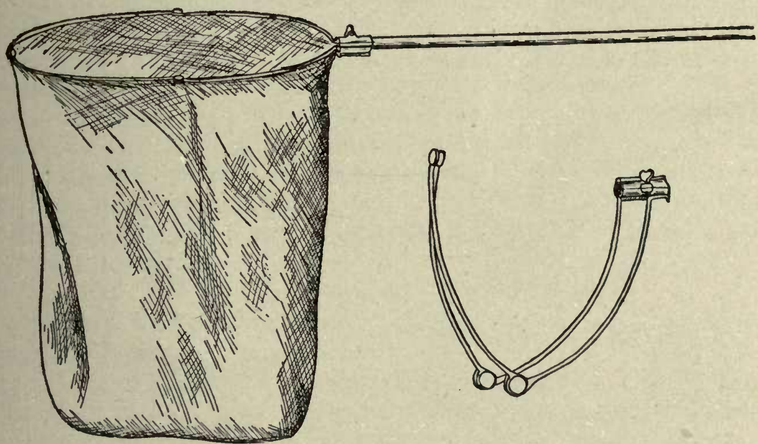


FIG. 34.—A convenient collecting net.

Killing Special Insects.—The writer sometimes lulls stinging insects to unconsciousness by placing the point of the net in the bottle, and holding the cork over the mouth for a minute, when the bee or wasp can be taken out safely, and dropped into the killing bottle to complete the operation. Butterflies and moths should not be permitted to flutter about in a cyanide bottle, thus denuding the wings of their beautiful scales. They may be pinched between thumb and finger while still in the net (Fig. 35), or a drop of chloroform may be placed on the thorax and abdomen, and then the insects transferred to the cyanide bottle. Plant lice are best killed by dropping into vials of alcohol.

Jarring.—Some insects may be knocked off of shrubbery or branches of trees by jarring, the net being held below.

Water insects, such as "water boatmen," skippers and "whirligig-beetles," can be captured by using the net. Some larvæ can be found under stones, in ponds and streams. Those that frequent the bottom can be obtained by the use of a metal sieve-scoop, transferring the material—small sticks, mud, leaves, etc.—to a jar, whence the specimens can be separated later.

Where to Look for Insects.—Insects of various kinds are found in a host of localities, upon flowers, upon shrubbery, along the edges of woods, in the woods themselves, in pastures and meadows, along the banks of streams, lakes and ponds and in the waters of the same; in rotten logs and stumps, under logs and rubbish, under bark, in fruits, and in nuts, etc. The collector who has the keenest eyes is the one, other things being equal, most likely to succeed.

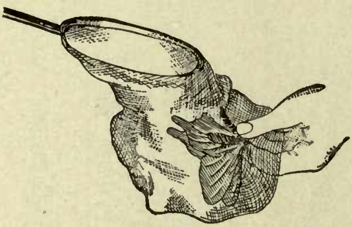


Fig. 35.—Method of handling butterflies caught in net. (After Holland.)

Baiting and Night Collecting.—While broad daylight and bright sunshine are the best conditions under which to collect the majority of insects, many are best collected at twilight, and night collecting by the use of baits is fascinating.

An acceptable bait is made of brown sugar and water, forming quite a thick syrup, and adding a goodly amount of stale beer or rum; put this on, say, twenty trees (it may also be used on fences or stumps) in the woods, just after sundown, spreading it with a brush over a space about three by eight inches, and noting carefully the baited trees, so that they can be found in the dark. If one starts out between nine and ten with a lantern, preferably a dark lantern, or electric flashlight, and several cyanide bottles, and visits the treated trees, flashing the light carefully on the anointed portions, one will probably discover moths and other insects at work sipping the attractive mixture. A collecting bottle is placed cautiously over one of these insects and moved to right or left slightly, thus loosening the insect from its hold, whereupon it falls into the bottle, the latter is tipped quickly and corked, placed in one's pocket, and a second bottle used for another insect. These insects are later united in one bottle, leaving one or more bottles free for use in capturing. Warm, still nights are best suited for this work.

Lights in an open window, or, better still, the electric lights in the streets of our towns and cities, offer excellent opportunities for night collecting.

Pinning and Spreading.—In pinning insects a Comstock spacing block will be found useful. Its construction is easily understood by a glance at figure 36. Each layer from which the block

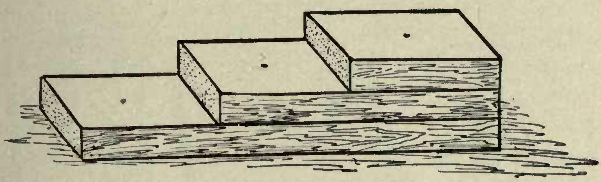


FIG. 36.—A block used in pinning insects, spacing block.

is made is one-fourth as thick as an insect pin is long. The hole on each step is large enough to admit the head of the pin. Each insect should be, when pinned, just one-fourth of the length of the pin from the head. This is brought about by inserting the head of the pin, after the pin has been pushed through the insect, into the hole of the lower step—the back of the specimen should rest

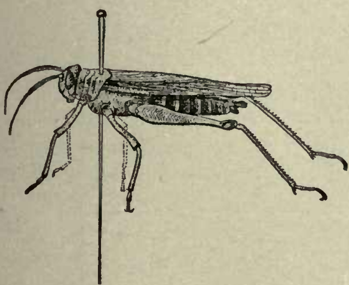


FIG. 37.—The proper way to pin a grasshopper.

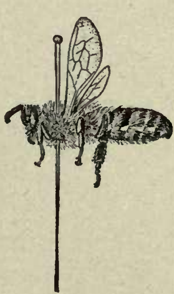


FIG. 38.—A bee properly pinned.

FIG. 39.—The proper way to pin a beetle.

on the step. By reversing the pin and using the first and second steps the proper spacing of labels is secured, and when small insects are mounted on points the hole in the highest step receives the point of the pin. The German insect pins appear to be the best, and are made in several sizes. Perhaps sizes 0, 1, 3, 5, and 9 would be those most commonly used by the amateur collector. The thing to be sought is uniformity in height of insects and labels in the box, that the collection may present a neat appearance.

Grasshoppers, bees and flies, butterflies and moths, etc., are pinned through the thorax, as shown in figures 37 and 38. Beetles are pinned through the right elytron, or wing cover, as shown in figure 39. Bugs are pinned through the median point of the scutellum (Figs. 40 and 41).

Fig. 40.—A true bug correctly pinned.

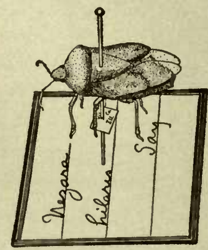


Fig. 41.—Labels, showing species and locality.

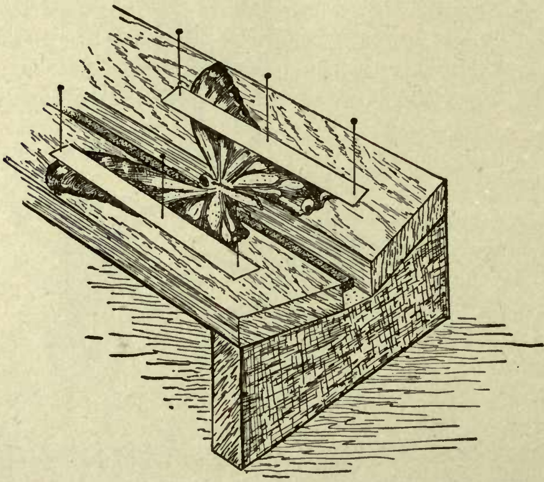


Fig. 42.—A spreading board for moths and butterflies.

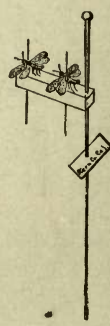


Fig. 43.—Microscopic insects mounted on pith block.

Butterflies and moths should be spread on a spreading board as shown in figure 42. They are transferred to the collection when dried. Frequently the wings of other insects are spread if a collector has time to go into such niceties.

Two dissecting needles, made by pushing the blunt ends of needles into round sticks 4 inches long, of the diameter of lead pencils, will be found useful tools in spreading.

Mounting on Pith and Cardboard Points.—Small moths and also other small insects are sometimes mounted on pith by the use of tiny wire, the pith being first fastened to an insect pin at proper height (Fig. 43). Again, a small beetle or fly, or other

Fig. 44.—Microscopic insect mounted on cardboard point.

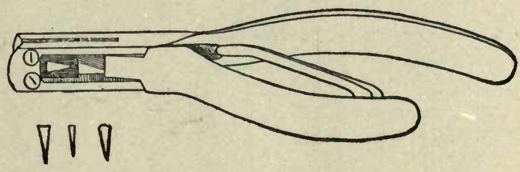


Fig. 45.—A punch for making points.

insect, may be mounted by being gummed to a cardboard point, as shown in figure 44. These points are made with a triangle punch illustrated in figure 45.

Pinning forceps are desirable accessories in order to hold the pin upright, and to keep it from bending when it is being forced into the cork bottom of the collection box. Figures 46 and 47 represent these forceps, the first used with lighter pins, and the latter where large butterflies, etc., are being placed in position in the collection. A cheap pair of pliers will answer fairly well if one does not care to go to the expense of the regulation forceps.

Very delicate insects, such as plant lice, minute flies, etc., which have first been in 90 per cent alcohol, are frequently mounted on glass slides, with appropriate labels (Fig. 48) for identification and study with the microscope.

Fig. 46.

Fig. 47.

Fig. 46.—Forceps for pinning insects.
Fig. 47.—Heavy pinning forceps.

Magnifying Glass.—In studying and handling small insects a watchmaker's glass (Fig. 49) is sometimes quite useful. This lies in the fact that it can be held in one eye, leaving the hands free. A pocket lens (Fig. 50) of some kind is very desirable.

Preserving Bottles.—Figure 51 illustrates a home-made rack for holding vials, containing alcoholic specimens to be studied.

Figure 52 shows the Comstock insect bottle, used by many entomologists for the permanent storing of insect larvæ, pupæ, etc.

Inflating and Mounting Caterpillars.—Frequently one wishes to preserve a caterpillar in the dry state for mounting by the side of the imago. Kill the specimen in the cyanide bottle; make a small slit with a fine pair of scissors at the extreme posterior end

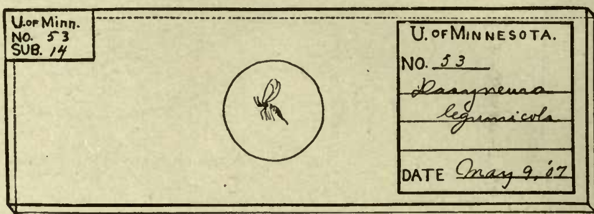


Fig. 48.—Insect mounted on glass slide, with labels.

of the caterpillar. A better way, perhaps, is to insert the point of a pin about one-eighth of an inch into the anal opening at the posterior end of the caterpillar, and move it carefully around in order to cut through the intestinal wall, thus freeing it from its attachment to the body wall.

Place the larva on blotting paper, and, placing a round pencil

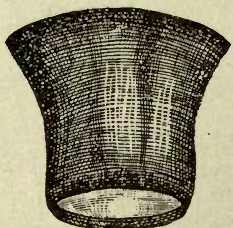


Fig. 49.—Watchmaker's glass useful in entomological work.

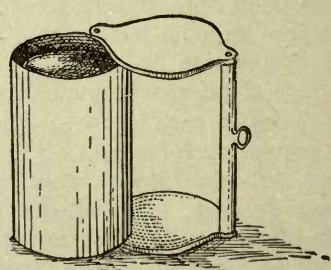


Fig. 50.—Coddington hand lens.

upon it just back of the head, roll it backward gently, pressing out the viscera. Care must be taken to move the caterpillar about during this in order to keep the hairs dry.

Then insert a straw or a glass tube drawn nearly to a point, about one-fifth of an inch, into the opening. If a straw is used, push a fine pin through the specimen close to the posterior end and through the straw. This will hold it in place while inflating. If

one uses a glass tube, it should be held over a flame until the specimen is dried to it at the point of contact. Should there be any openings between the straw or tube and skin of the caterpillar, a drop of glue will seal them. The actual inflating is done by holding the specimen in a warm place for a few moments, keeping it inflated to natural size until dry. This may be accomplished by the use of a simple apparatus and one's breath, as shown in figure 53. The lamp chimney rests upon an iron saucer filled with sand. One may prefer to purchase an inflating outfit, one of which is illustrated in figure 54, in which case the air is forced into the caterpillar from two bulbs. Care must be taken not to scorch the specimen. When thoroughly dry it may be pushed off the tube with a sharp knife.

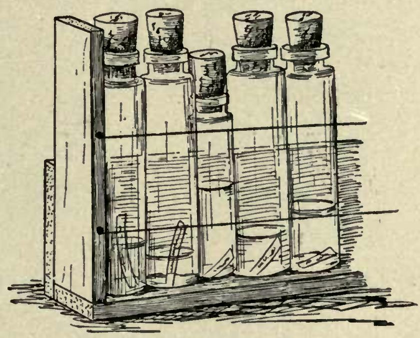


Fig. 51.—Stand for bottles.

A mount for the caterpillar has been previously prepared. This will be understood by a glance at the accompanying illustration (Fig. 55), which shows a piece of cork at the proper height on an insect pin, and some fine wire (preferably the covered wire used

Fig. 52.—A Comstock bottle for alcoholic specimens.

by milliners) wrapped about it as shown. The two ends are left twisted together, and upon these the caterpillar is thrust, a drop of liquid glue having first been placed on the wires' ends. The specimen is then ready for the label.

Rearing Larvæ.—A collector may be uncertain about the identity of a captured larva, or he may wish to procure the imago for his collection, or he may desire to study its life history, observe its

moults, etc. This is easily accomplished, whether it be the young stage of butterfly, moth, beetle, fly, or bug.

The specimen or specimens are confined in some form of breeding jar with an abundance of food. If the food be a plant, a flower pot containing the same may be placed in the cage as shown

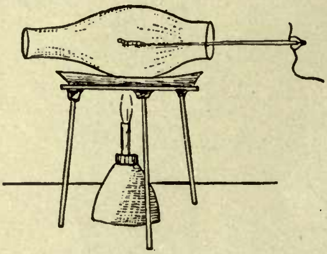


FIG. 53.—Home-made apparatus for inflating larvæ.

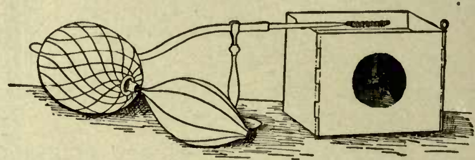


FIG. 54.—A more expensive apparatus for inflating larvæ.

in figure 56, which illustrates a home-made outfit in use. Or a lamp chimney, or lantern glass, with cheesecloth over the top, may be placed over small plants upon which the insect feeds, the glass being pushed into the soil of the pot about an inch.

Water insects can be studied in the same way by making an aquarium, as shown in figure 57, in which a few water plants are grown, and the water of which is kept fresh.

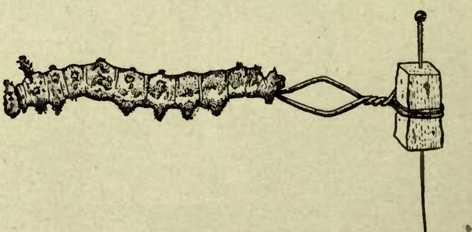


FIG. 55.—An inflated larva properly mounted.

The development of larval stages, wire worms, for example, which infest roots, can be studied in a Comstock root cage (Fig. 58). This, as shown in the illustration, consists of two plates of glass held a short distance apart by a supporting frame. This narrow space is filled with soil, and seeds of young plants placed therein.

Careful and frequent observations should be made of insects

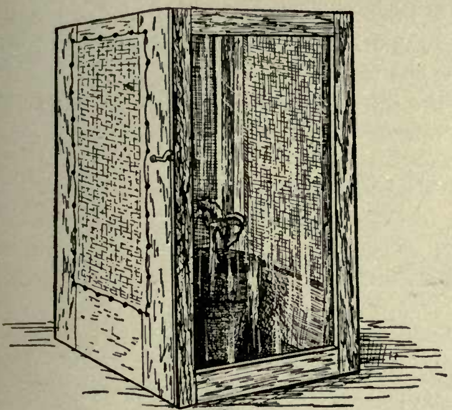


FIG. 56.—A simple form of breeding cage.

FIG. 57.—A home-made breeding jar for aquatic insects.

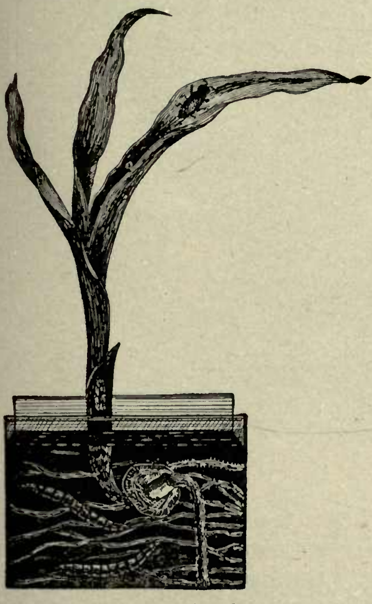


FIG. 58.—Corn growing between two glass plates for study of root forms. (After Comstock.)

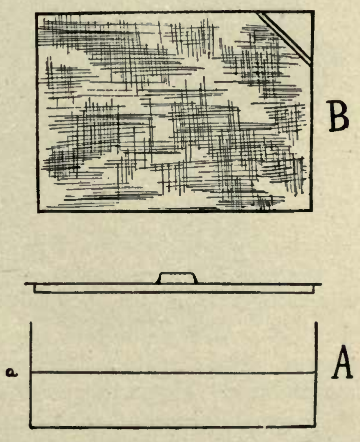


FIG. 59.—A, vertical section of moist chamber used in relaxing dried specimens. B, partition of brass or copper gauze, supported at *a*, upon which insects are laid.

in breeding cages, and notes made of dates of capture and condition of specimen, moults, pupation, emergence of imago, etc. Frequently, what appears at the time to be a trivial fact may be an important contribution to the science of entomology, particularly if the specimen be a pest to agriculture.

Relaxing Dried Specimens.—Any insect which has become dried in storage, before being pinned, has to be relaxed before it is handled. We, for years, made use of a relaxing box shown in the accompanying illustration (Fig. 59), and found it very satisfactory. It shows the box and lid in section, A marking the point at which

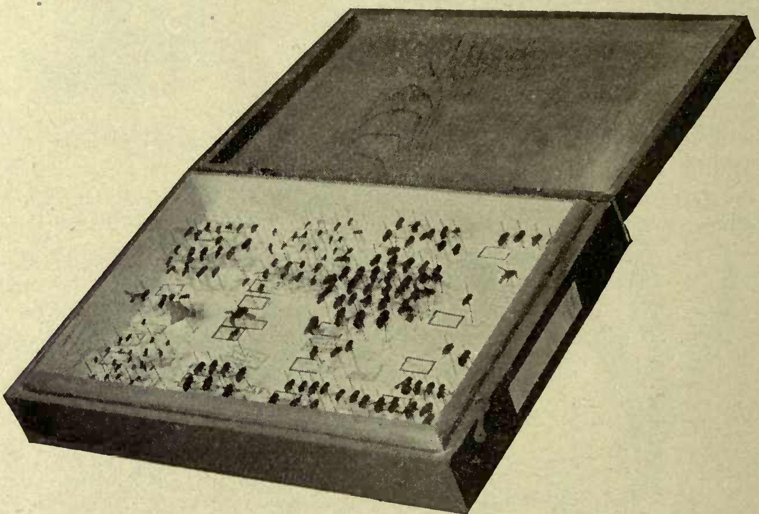


Fig. 60.—A Schmidt insect box.

the wire gauze forms a false bottom a few inches from the floor of the box. B shows surface view of the gauze, the opening in the corner affording an opportunity to pour water into the bottom of the box. A little carbolic acid is placed in this water to prevent mould. The insects are left on the gauze over night, with the cover on the box. This will generally cause them to be so relaxed that they can be handled with safety. The box may be made of galvanized iron, and this particular box is 9 x 14 inches and 5 inches high, the gauze being placed two and one-half inches from bottom. A glass fruit jar containing some wet blotting paper is a simple relaxing chamber.

A tight dust-proof and insect-proof box is necessary to hold a permanent collection. Ideal boxes are seen in either the Schmidt box, illustrated in figure 60, or in a Comstock box. Collections should be examined every few months to prevent dermestids or other pests from working injury. If evidence of their presence is observed, the box and its contents should be subjected to the fumes of carbon bisulfid in a closed receptacle for several hours. Two treatments, with ten days' interval between, may be necessary. Most entomologists keep naphthaline cones (Fig. 61) in their insect boxes as repellents. It is not safe to store insects permanently in unprotected cigar boxes.

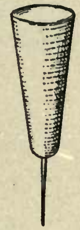


FIG. 61.—A naphthaline cone.

Mailing and Storing.—In mailing insects in vials, round mailing boxes (Fig. 62) are made use of, the vial being wrapped in cotton. Figure 63 shows the method of cutting and folding papers for butterflies and moths, either when they are to be mailed (in which case they would be packed flat in boxes), or when they are to be kept in storage. Avoid moisture in packing

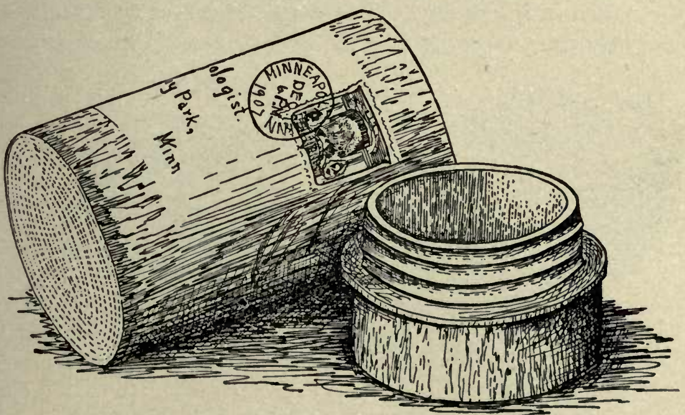


FIG. 62.—Mailing box for vials.

away insects, and protect them from the attacks of mice and museum pests. Specimens of a miscellaneous nature may be mailed or stored in boxes between layers of cotton, a piece of tissue paper being placed below and above them to keep them from actual contact with the cotton. This is a good method to be followed by students making small collections, required for a school or college course.

Keeping Records.—Some form of entomological bookkeeping is desirable for any one wishing to make an extended study of the subject. Observations in the field or in the insectary can be made upon small sheets of perforated paper, temporarily bound in leather covers of a size suitable for the pocket, care being taken not to

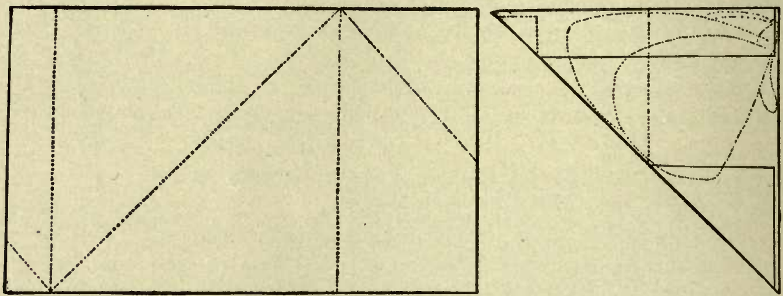


FIG. 63.—Showing method of making envelopes for butterflies.

write an observation upon two or more insects on the same sheet. These sheets can later be removed from the temporary cover, and each one filed in a box devoted to a special insect or a special set of observations. Accessions to the collection may be entered in a

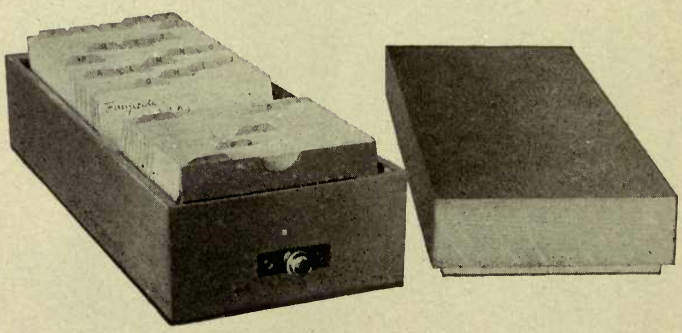


FIG. 64.—A convenient form of card index and container.

book, the accession number referring to a special collection or set of insects, and the sub-numbers placed on the side referring to the individual specimens in the collection. In this case the insect would bear a label showing its accession number and sub-number, as in figure 48.

A card index (Fig. 64) is found to be a very valuable aid, by

forming a handy record of literature, illustrations, lantern slides, cuts or special lines of work, and can well be used as an accession index also. The *necessity of having specimens in a collection carefully labeled, and all data where they can be referred to, cannot be too strongly emphasized.*

QUESTIONS

1. Describe the making of an insect killing bottle.
2. Describe some special methods in collecting insect specimens.
3. Describe the form of net which you prefer.
4. Tell how to manage butterflies and moths to prevent fluttering.
5. How would you manage to collect water insects?
6. What are some of the best places to look for insect specimens?
7. Describe some methods of baiting insects.
8. Give important points in pinning insects.
9. Describe a good spreading board and give details of how to use it.
10. Give directions for inflating and mounting caterpillars.
11. Give important points in rearing larvæ.
12. How may dried specimens be relaxed?

CHAPTER V

INSECTICIDES AND SPRAYING

For the purpose of combating insects the farmer, orchardist and gardener, disregarding scientific classification, need consider only two groups:

A. Biting insects, or those which devour leaves, stems, stalks of grain, grasses, and fruit. Examples of these are seen in grasshoppers, caterpillars of all sorts (including cut-worms and army worms), and in beetles and so-called "slugs," the larvæ of saw flies.

B. Sucking insects, those which pierce the surface of leaf or fruit, skin of animals, and suck the sap of plants or the blood of animals from below the surface.

Manifestly two entirely different classes of insecticides are necessary in combating the two groups.

Internal Poisons.—Group A calls for internal poisons, poison sprays or poison baits, which taken internally result in the death of the insects in question. Such poisons are found in a number of forms.

1. **White arsenic** or arsenious oxide (As_2O_3) is soluble in water, and is dangerous to both plants and human beings and hence not desirable.

2. **Paris green** is a combination of arsenic and copper with a certain amount of free arsenic occurring in the compound. Some states limit it by law to 50 per cent arsenious oxide and 3½ per cent water-soluble arsenic. This insecticide costs from 25 cents a pound up, depending upon the copper market and the avariciousness of the dealer. Care has to be exercised in its use, otherwise sprayed foliage is apt to be burned. It should never be used on evergreens.

A few simple tests are available to the farmer buying Paris green. It should not be purchased at retail from open sacks or other open containers where it is kept in bulk. It should be bright green in color, not pale green. A small amount taken on a knife blade, deposited on a piece of glass, and the glass then inclined and gently tapped should leave on the glass a green streak; if decidedly pale green or whitish the Paris green is adulterated.

Another test is to add a small amount (½ teaspoonful) to a

small glass of ammonia; the Paris green should completely dissolve. If it does not it is evidently adulterated.

If a microscope is available and a little pure Paris green is examined it will appear made up largely of regular, more or less spherical, bodies with smooth edges (Fig. 65); if adulterated many irregular-shaped particles will be observed mixed with the more spherical bodies (Fig. 66).

The fact that there is some free water-soluble arsenic in Paris green, which amount may be illegally excessive, makes it more or less dangerous to use in the hands of a careless grower, for, as intimated above, it is very likely to burn tender foliage. At the same time some crops can stand a large amount of this insecticide

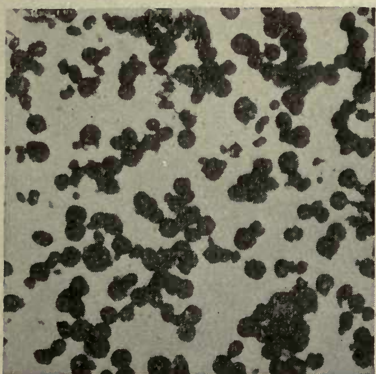


Fig. 65.—Good Paris green, as it appears under the microscope.

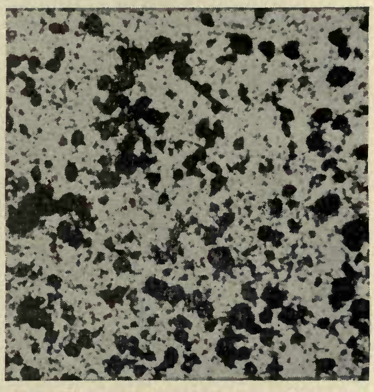


Fig. 66.—Poor Paris green as seen with the microscope.

without injury. Cabbage plants, for example, when good-sized, show no serious effect when sprayed with soap and Paris green at the rate of five pounds of the latter in fifty gallons of water. Less than one-half of those proportions would burn the leaves of apple trees.

Use Lime with Paris Green.—This burning quality of Paris green can be restrained by the use of two pounds of quicklime for every pound of Paris green used. Since the larger part is not soluble in water, but is held in suspension simply, there should be constant agitation of the liquid while spraying.

3. Arsenate of Lead Paste.—This contains less than 1 per cent of free or soluble arsenic and about 15 per cent of arsenic oxide. It is a much safer and more satisfactory poison than the

foregoing. It rarely injures foliage and has the property of sticking to leaf and fruit much longer than Paris green. It is always used at a greater strength than Paris green is used, and with perfect safety. Its effect is not always so marked as the latter and in at least one instance requires the addition of a little Paris green to be really effective. The adult potato beetle is referred to, which will hardly yield to arsenate of lead, although the latter is sufficient to kill the larvæ. Potato growers are advised to use two pounds of arsenate of lead and one pound of Paris green in fifty gallons of water.

Arsenate of lead paste may be made at home, but with difficulty, and the commercial article is preferable. Directions for use of this and most other insecticides and fungicides are printed on the can label.

A powdered form of arsenate of lead may be purchased, which can be mixed with water, but is perhaps not as satisfactory as the paste. It is quite effective if it is mixed with air-slaked lime and dusted on plants after a rain or when wet with dew.

4. London purple is a by-product in the manufacture of aniline dyes. It contains so large and such a varying percentage of soluble arsenic that it is not a safe agent. It is little used at present, but its cheapness is attractive.

5. Combined Insecticide and Fungicide.—Orchardists' needs frequently require that fungous diseases and insect pests may be treated in one spraying. Arsenate of lead may be safely and effectively added to commercial lime-sulfur. Potato growers, however, should combine Paris green with Bordeaux mixture. The last-named fungicide is made by combining four pounds of copper sulfate or blue vitrol, four pounds of quicklime, and fifty gallons of water as follows:

Making Bordeaux Mixture.—The four pounds of copper sulfate are suspended in a cloth sack in twenty-five gallons of water in some wooden receptacle. It will take several hours for this to dissolve. In another wooden receptacle (a barrel, for example) four pounds of quicklime are slaked in just enough water for this purpose, and enough more water gradually added to make twenty-five gallons. These two solutions may be then united or equal portions taken from each container as desired. This compound, like all other spraying mixtures, should be carefully strained before being placed in the spray pump reservoir, barrel, or tank. Bordeaux mixture should be used as soon as made; it changes on stand-

ing. Several commercial mixtures of prepared Bordeaux combined with arsenate of lead are on the market.

6. White Hellebore is not poisonous to human beings, but deadly if eaten by insects, and is very useful if used fresh. It loses its strength rapidly when exposed to the air. It is a product of the white hellebore plant and is generally used in the dry form, by dusting it over the plant. It may be made into a decoction (one ounce in two quarts of water) by steeping, and used as a spray.

7. Proprietary Insecticides.—Under this head are classed quite a number of compounds with attractive names, but of questionable utility. Many of them are valueless, or, if of any merit, cost three or four times as much as a farmer need pay.

8. Poison Baits.—Attractive baits may be made which contain poison:

Poison Bran Mash.—This is very effective against cut-worms, army worms, and grasshoppers. It is made as follows: Paris green is mixed with dry bran until the latter becomes quite green. Proportions approximate one pound Paris green to 20 or 25 pounds of bran. To this dry mass are then added water and about two quarts of cheap syrup or molasses and the mixture stirred. It should be of the consistency of chicken feed, not sloppy. For cut-worms a tablespoonful of this is placed near a plant, perhaps eight inches away. If placed too close, a copious rain may wash the Paris green onto the roots, destroying the plant. For both cut-worms and army worms covering large areas, it is broadcast among plants, or, from a tub on a stoneboat, over fields infested with grasshoppers.

Dean, of Kansas, recommends, for grasshoppers, adding the juice and pulp of three oranges or lemons to a mixture of one pound Paris green, twenty pounds wheat bran, two quarts of syrup and three and one-half gallons of water. Some workers, however, claim that the addition of the fruit does not make any material difference in the attractiveness of the bait.

For cut-worms, where Paris green is too expensive or not procurable, ten pounds of bran may be poisoned with one pound of arsenic, mixed into a dough with water and where practicable with molasses or cheap syrup.

A bait made of alfalfa or clover, freshly cut and dipped into a solution of arsenic and water and distributed in small bunches at sundown or after, is quite effective against cut-worms. It may also be used against prairie dogs. When dried by the sun this bait is not attractive.

Poisoned Grain.—Corn may be soaked in a strychnine solution, rendering it poisonous to crows, squirrels or gophers, and may be scattered about in fields where crows are working. The method of making and using this solution is as follows:

One ounce of sulfate of strychnia is dissolved in two quarts of boiling water. This is sufficient to treat a bushel of grain, which should soak over night. The poison should be prepared and mixed with the grain in a metal container and the latter thoroughly cleansed after the operation. Wheat is used when mice or gophers or prairie dogs are to be poisoned. Crushed or rolled oats form a good basis for a poison bait. Seed corn may also be safely treated with this preparation. The United States Department of Agriculture (Farmers' Bulletin 670) recommends for field mice the adding of two tablespoonfuls of laundry starch in one-half pint of cold water to either of the above poisons, pouring the starch into the solution and boiling for a few minutes, then pouring it over the grain. Care should be taken to prevent stock or poultry having access to poison baits.

Tarred corn can be prepared in such a way as to enable it to pass easily through the planter (see under Crow, page 405). This treatment also renders it distasteful to wire worms, squirrels and gophers which sometimes attack the planted seed.

9. Arsenite of Soda.—One-fifth ounce of arsenite of soda, one-half pint of New Orleans molasses and one gallon of water sprayed on young cabbage, cauliflower, onion plants and radishes attract and poison the adult flies which produce the destructive maggots. To be effective they must be applied early, before egg laying begins.

Bait for Sow-bugs.—Paris green or arsenic on slices of potato is claimed to be a successful bait for sow-bugs (not insects) in greenhouses. We have successfully used a mixture of Paris green and sugar. The *Florists' Review* advises for sow-bugs, two parts rye flour, two parts sugar, one part Paris green, kept dry and frequently renewed.

Insecticides for Sucking Insects.—Contact insecticides are intended for such insects as do not eat the surface of plant, but suck the sap from below it. Entomologists formerly believed that soap, oil, or oil mixtures killed by stopping the spiracles and thus "smothering" the insect. This theory appears to be, in part at least, disproved, since insects can live a long time without access to oxygen. It is now thought that their death is due to volatile substances in oil or soap.

Kerosene Emulsion.—This compound has been largely superseded by soap solutions and tobacco extracts, because to be a safe agent it must be made and used correctly; if not, the kerosene, separating from the emulsion, gathers at the top of the mixture, and when the spray pump draws this layer off and applies it to foliage severe burning is the result. The approved formula for kerosene emulsion is: One pound soap, dissolved in two gallons of hot soft water. When boiling hot this is taken from the fire and four gallons of cheap kerosene added, the mixture being at once churned by means of a force pump until a creamy, white emulsion is formed. This is the stock solution. For summer spraying add thirty-four gallons of water to this; for dormant or winter spraying add from ten to fourteen gallons of water. Keep the liquid well agitated while spraying.

Avoid any mechanical mixture of oil and water; and never use pumps advertised as mixing oil and water mechanically. In using any dormant or winter spray it should not be applied in severe weather; in other words, freezing of the spray on the tree should be guarded against.

Crude Oil Emulsion.—Made in the same way as the above, employing crude petroleum in place of kerosene. A 20 per cent solution is used as a dormant spray against scale insects.

Distillate Emulsion.—Thirty pounds whale oil or fish oil soap dissolved in twenty gallons of water by boiling. Add twenty gallons of distillate and churn while hot. When wanted for use, add 20 gallons of water to every 1 gallon of stock.

Lime-sulfur.—While this may be made at home, it is one of the few proprietary compounds which can best be purchased. Complete directions for use are given on containers. Primarily a fungicide, it forms an excellent insecticide for scale insects and many other pests. It can be used both as a dormant spray and, much reduced by the addition of water, as a summer insecticide or fungicide. Combined with arsenate of lead, it affords a means of prevention for both codling moth or curculio injury and the apple scab. It is to be regarded as one of the most useful agents in the work of the orchardist. The stock solution will stand a very low temperature, possibly five or ten degrees above zero without freezing.

Soap Solutions.—It is doubtful if true whale oil soap is on the market at this time. If so, the price must be prohibitive. It would be safer to assume that soap advertised as whale oil soap is

made from fish oil. Ordinary laundry soap and ivory soap are both efficacious against lice and harmless to foliage or fruit.

A five-cent cake of ivory soap dissolved in five or six gallons of hot water or one pound of laundry soap in the same amount of water is an excellent remedy for plant lice, and will not injure the most tender foliage. It is best used warm, and a little tobacco decoction, either made from stems or purchased, if added to the soap solution increases its efficiency.

Tobacco Extracts.—While a fairly efficient extract may be made by steeping tobacco stems or other waste forms of tobacco, it is better to rely upon the commercial extract at present on the market. "Black Leaf 40," a nicotine sulfate solution, gives excellent results. The commercial form may usually be used in place of the patent preparation. It is expensive, but can be effectively used in such extreme dilution that the final cost is slight. For example, one or two tablespoonfuls in a gallon of water are most effective against plant lice, and if this solution is poured several times at intervals around the base of melon vines it forms an exceedingly helpful remedy for the larvæ of the striped cucumber beetle working on the roots.

Nicofume is another tobacco solution. It is vaporized in greenhouses; and a prepared paper (Nicofume paper) is burned as a fumigant against lice on melons and in greenhouses. It is prepared by soaking porous paper in tobacco extract or nicotine sulfate. After drying it may be burned, causing the desired fumes.

Tobacco Dust.—This is finely powdered product, used on young radishes against root maggot, and on dahlia and aster buds against tarnished plant bug. It is also of practical use in greenhouses.

Flowers of Sulfur.—This material is dusted on steam pipes in greenhouses, but is only fairly effective against the "white-fly." Mixed with air-slaked lime it is used for control of red spider and mite.

Pyrethrum, Buhach, Persian Insect Powder.—This is made from the pulverized heads of a species of chrysanthemum. Must be used when fresh to be effective. Harmless to human beings and to foliage. It is either dusted on plants or steeped for several minutes in water, one ounce of pyrethrum to three quarts of water.

Air-slaked Lime.—This is an excellent and cheap deterrent and insecticide for many insects. Dusted on leaves of fruit trees, it is deadly to the leaf-eating "slugs." It saves to a large extent

potato vines from attacks of flea beetles. It drives striped cucumber beetles away from melons and cucumbers.

Road dust is used effectively against slugs on foliage.

Crude Carbolic Acid.—Dissolve one pound of hard soap[1] in one gallon of water by boiling, add one pint of crude carbolic acid and churn by forcing it with a spray pump over into itself until emulsion is formed. The stock solution should be diluted with about thirty parts of water when wanted for use. It is employed against root maggots, but the arsenite of soda spray appears to be more effective and easier to prepare. Diluted one part of stock carbolic solution to twenty parts of water, it is used in California as a spray against mealy bugs, plant lice and soft brown scale.

FIG. 67.—A hand dust sprayer at work in a nursery.

Hot Water.—Boiling hot water, poured upon plants from a watering pot held above the plants, has sufficient heat to kill caterpillars (green cabbage worms, for example) without injuring the foliage.

Dust Spraying Versus Liquid Spraying.—This subject is one of some controversy between workers, with most of the evidence in favor of the latter process. However, where water is scarce, or when orchard trees or other crops are on steep hillsides where liquid cannot well be hauled, the dust spray appeals to one strongly.

[1] Wherever hard soap is mentioned in the above suggestions it can be replaced with soft soap by using twice as much of the soft soap as directed for the hard soap.

Other advantages of the dust method are as follows: The cloud of dust envelops immense numbers of trees, one barrel of dust, it is claimed, under proper conditions, being sufficient to cover five hundred trees; one cannot get on too much of the dust; it commends itself for small plants such as cabbages, currants, and strawberries; it is somewhat less expensive, both in labor and material, than using the liquid spray; one hundred large trees can be dusted in one hour at an average cost of about one cent per tree (Figs. 67 and 68).

Its disadvantages lie in several facts: When a strong wind is blowing it cannot well be used, because one is obliged to keep to windward side of trees constantly; it is best used when the dew is

Fig. 68.—A larger dust sprayer on wagon.

on the trees or plants, thus relegating the work to the early morning hours; it is not especially effective against the codling moth; on account of the clouds of dust it settles on horses and workmen much more readily than liquid spray; is not nearly as effective against sucking insects as the recommended liquid sprays.

In connection with the subject of dust spray it is interesting to note that one barrel of quicklime will make two and one-half barrels of dust (air-slaked lime); five pounds of Paris green to every barrel of lime is the proper proportion to be used against biting insects; it should be repeated several times. For canker worms, however, one should use ten pounds of Paris green to every barrel of lime; and for potato beetles and green cabbage worms twenty-five pounds to every barrel.

In using a liquid spray, apply until the liquid drips from the tree. Never spray a tree in bloom, because of danger to visiting bees.

MECHANICAL MEASURES AGAINST INSECTS

1. Trap Crops.—A crop not desired by the farmer may be used to attract insect pests which might otherwise attack a valuable crop. For example, millet planted about a corn field will protect the latter crop from chinch bugs, which prefer the millet and may be destroyed thereon.

2. Lantern Traps.—A lighted lantern suspended at night over a tub partially filled with water covered with a film of kerosene will attract large numbers of May beetles or "June bugs" (Fig.

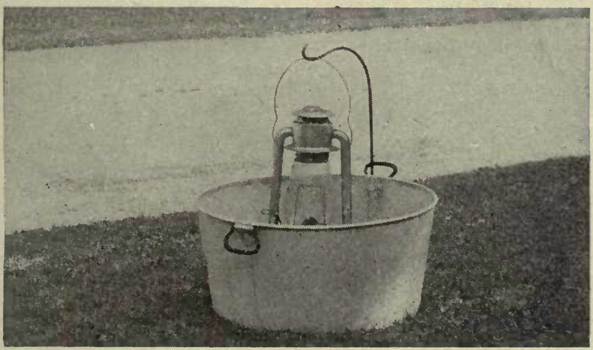


Fig. 69.—A lantern trap for catching June beetles.

69). This remedy should be used at the very first appearance of the insects, before the females have laid their eggs.

3. Bands of burlap or other material about apple trees afford a nesting place for larvæ of codling moths. The larvæ or pupæ under the bands may be destroyed at intervals.

Traps for encircling trunks of trees, preventing the ascent of canker worms, are on the market.

4. Tree Tanglefoot.—This is a manufactured sticky compound used as a band on trunks of trees to prevent ascent of wingless moths and caterpillars; when used on young and tender-barked trees, these must be protected by paper or cloth so that the tanglefoot will not come in direct contact with the tender bark. This paper or cloth should not be tied on young trees with a tight string and left during the growing season for fear of girdling the tree.

5. Hopperdozers.—Various forms of these may be constructed to combat grasshoppers or other jumping insects (Figs. 70 and 71).

6. Ditches may be dug around a threatened crop to prevent inroads by chinch bugs, army worms, field mice, gophers, etc. (see discussion of these pests).

7. Dust furrows may be used against an advancing army of chinch bugs.

8. Oil barriers are also used to check chinch bugs where dust furrows are not practicable.

9. Tarred Paper or Tarred Felt Disks.—These are placed on cabbage or cauliflower plants when set out, to prevent eggs of cabbage maggot being placed thereon.

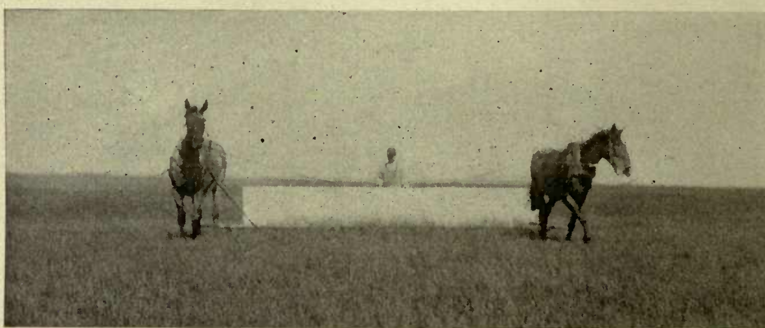


Fig. 70.—Working against grasshoppers with a "hopperdozer."

10. Covering of Seed Beds and Plants.—Cabbage and other plants in coldframes are protected by screens. Melons and cucumber plants may be guarded against insect attack until well started, by wooden frames covered on top with cheesecloth.

Wash for Tree Trunks and Limbs.—Several washes for protection of trees against borers are in use. They act as deterrents and some of them as poisons for the young grubs entering the tree. All are more or less effective, but must not be relied upon absolutely. The following is an example: Two quarts of strong soft soap (or one pound hard soap) dissolved in a bucket of water. Add one-half pint of crude carbolic acid and two ounces of Paris green. Then add lime or clay, or both, to make it a thick paste (O'Kane). Probably two applications of this wash during the year would be necessary.

Never use an oil paint—white lead, for example—or any form of boiled linseed oil on trunk or limbs.

12. Jarring trees is useful to dislodge beetles and let them fall on sheets below.

13. Hand Picking.—Large caterpillars and other insects may be easily picked off of trees and plants.

14. Burning of Caterpillar Nests.—Tent caterpillars and the fall web worm may be burned by touching their nests with a burning rag and saturated with kerosene wired to a pole. This should be done at a time when the caterpillars are "at home."

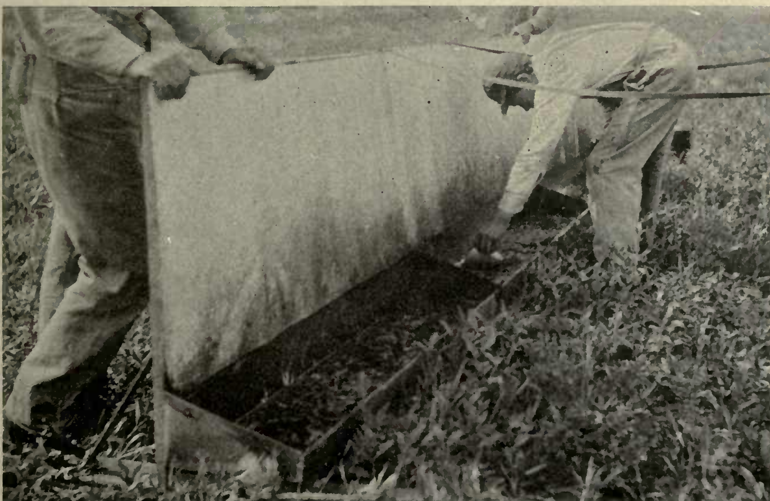


FIG. 71.—Removing dead grasshoppers from the hopperdozer.

SPRAY PUMPS AND SPRAYING

Cheap spray pumps should be avoided, and a high price should not be paid for an inferior article, which is not dependable. A hand atomizer or sprayer for use in flower gardens or where only a few plants are concerned can be bought for from $1.00 to $3.00; a bucket pump (Fig. 72) used in connection with bucket or pail may cost from $6.00 to $7.00, while knapsack sprayers (Fig. 73) cost from $10.00 to $14.00, and a barrel pump, most serviceable and satisfactory for a medium-sized orchard, will cost from $14.00 to $16.00, without the barrel. Power sprayers, run by gasoline, will amount in price from $125.00 to $300.00.

The essential points are that all valves are of the ball type, and

working parts of brass or bronze. Leather or rubber valves are not used in the best pumps. Cylinders lined with porcelain are not desirable. A farmer or fruit grower with a medium-sized orchard should be willing to pay anywhere from $12.00 to $20.00 for a good pump. A purchaser should insist on seeing the inside of a pump before buying. In getting the more expensive pumps, several growers might unite, thereby being enabled to purchase a good article with comparatively small expense to the individual.

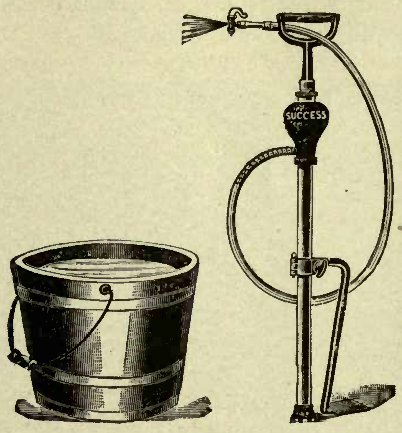


Fig. 72.—Bucket pump.

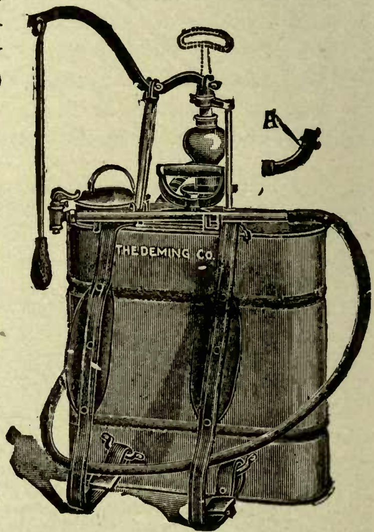


Fig. 73.—A knapsack sprayer.

Fig. 74.—A barrel spray pump, showing agitator.

Some Good Types of Sprayers.—Figures 74, 75 and 76 illustrate types of barrel pumps, and figure 77 a double-action pump. Figure 78 is a combination barrel pump and cart, and figure 79 a one-man outfit,

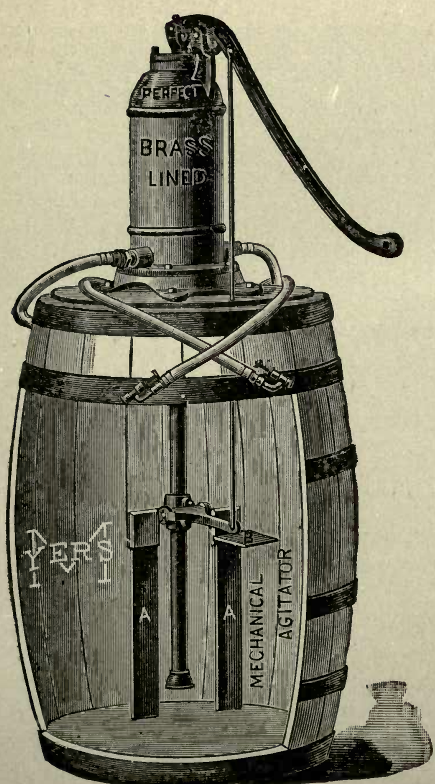


Fig. 75.—Another style of barrel pump.

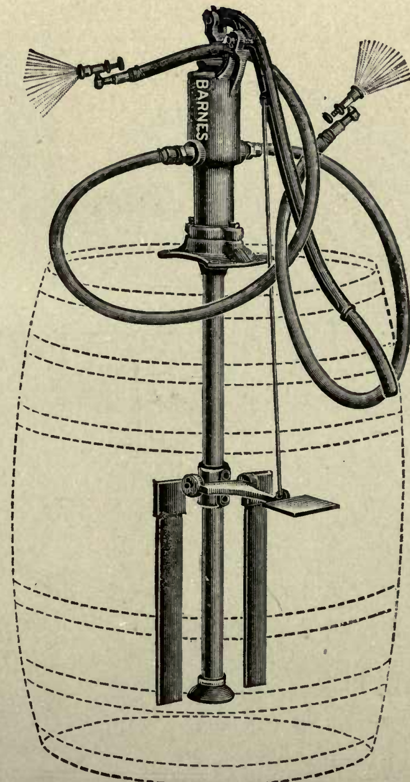


Fig. 76.—A third style of barrel pump.

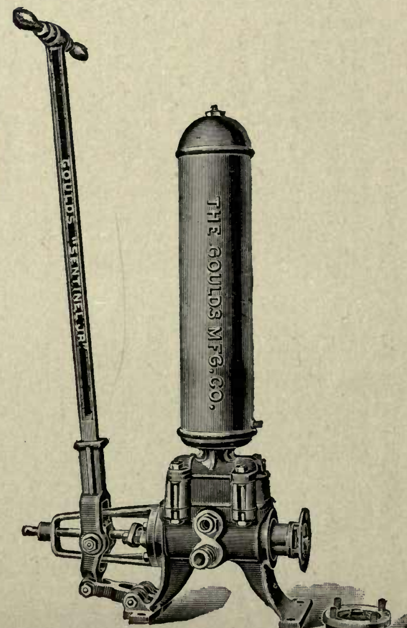


Fig. 77.—A double-acting pump.

which has been found most serviceable in experimental work. It is an excellent apparatus for a few small trees, garden vegetables, and other plants and shrubbery. Tall trees may be sprayed from a home-made tower as shown in figure 80, or with a more modern apparatus, run by gasoline power, shown in figure 81. Low plants in acreage amount, like large fields of strawberries, for example, are well handled with an outfit as shown in figure 82, or its equivalent.

Hose and Extension Rod.—Connections of good hose are important, and poor hose should be avoided; three-ply and four-ply

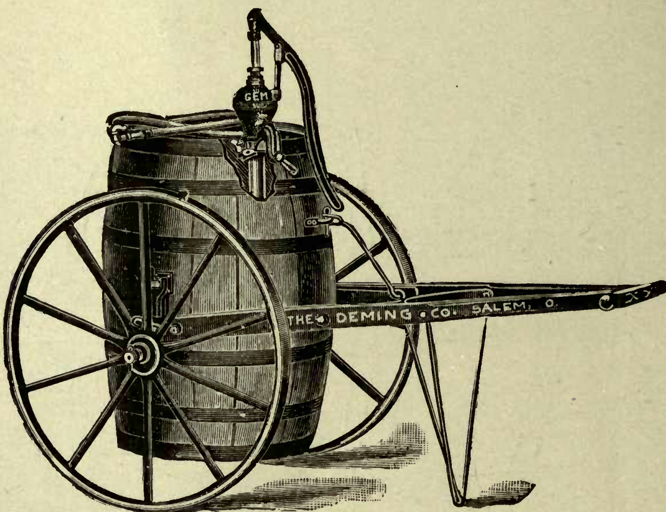


FIG. 78.—Barrel pump with cart.

are generally used, but where great pressure is to be needed, five- or even six-ply is desirable. Hose can be bought of any length. Where trees of some height are to be sprayed, extension rods are necessary (Fig. 83). These extension rods can be bought of various lengths, and consist either of metal pipe alone or the same encased in bamboo. To the ends of this the hose and nozzle are attached. Drip guards which encircle the extension just below the nozzle, or just above the point where it is held, will add to the comfort of the man spraying. These guards catch liquid which would otherwise run down the pole upon his hands.

A nozzle which can be readily cleaned is important, and one

Fig. 79.—A very serviceable outfit.

Fig. 80.—A home-made tower.

which applies the liquid in a fine spray and with force. The Vermorel type is the most desirable, and of recent years the nozzles known as the "Friend" and the "Mistry" appear to give best results. When Bordeaux mixture or whitewash is to be used, a "Bordeaux" nozzle is best. A nozzle with sharp angles or projections is apt to catch on twigs and branches while in use. Figures 84, 85, 86, 87 and 88 illustrate different types of nozzles. The disc type, of which the "Mistry" is an example, shown in figure 87, B, B[1] and C, and in figure 88, 2, receive most favorable comment in connection with tree spraying.

FIG. 81.—A sensible outfit for power spraying, where large trees have to be treated. (Courtesy of the Gould Mfg. Co.)

FIG. 82.—Three-row sprayer at work in a field of strawberries.

Never spray plants or trees when in bloom. Protect men and horses from lime-sulfur.

The Spray Itself.—Closely connected with the subject of a nozzle is consideration of the spray itself. The liquid must be

applied in the form of a mist, or very fine spray, and must strike the fruit, leaf or twig with force. A nozzle which will not do this is, with the exception noted below, of little or no value, so far as treatment against insect pests is concerned. Do not think that a mere sprinkling is going to do the work. Note, in this connection, that the old-fashioned field sprinkler which used to be employed in putting Paris green solution on potato vines has been replaced by the modern cart, geared to pump automatically, and furnished with nozzles which apply the liquid in a fine spray and with force. This is economy, for when there is but a coarse spray, or if the nozzle "dribbles," the liquid is wasted. It is economy, too, while seeing that every leaf and every part of the fruit or twig is well covered, not to waste the liquid by spraying too much; that is, the liquid should not drip off or run off the tree or plant to any great extent while being treated.

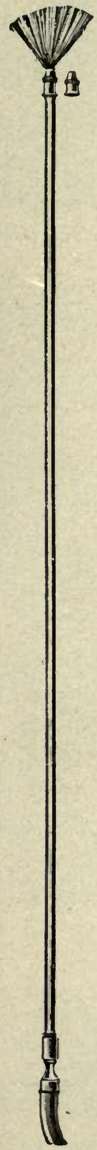


Fig. 83.—A bamboo extension.

Strainers.—All compounds used for spraying should be strained before or while being poured into the barrel or other receptacle from which they are to be drawn by the pump. If possible avoid using burlap for this purpose, as lint is bound to be carried into the pump, and is likely to give trouble by clogging the nozzle. Brass strainers are the best. They are made to fit the opening through which one pours the liquid. In addition to this, every good pump has a strainer in the lower end of the suction pipe or suction hose through which the liquid is drawn into the pump.

Agitators.—Most pumps—all good pumps—are equipped with agitators which, as a rule, the working of the pump handle keeps in motion (Figs. 74, 75, 76). These are generally paddles which keep the liquid in the barrel or other receptacle constantly stirred. Paris green, being heavier than water, sinks if the liquid is not kept constantly in motion, the result being that the poison is unevenly distributed, and a part of the tree or a portion of the plant will be injured or killed by receiving an unnecessarily large amount of the green, while other parts will receive

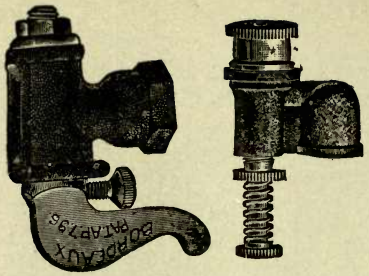


Fig. 84.—Nozzles of Bordeaux (left) and Vermorel type.

Fig. 85.—Double Bordeaux nozzle.

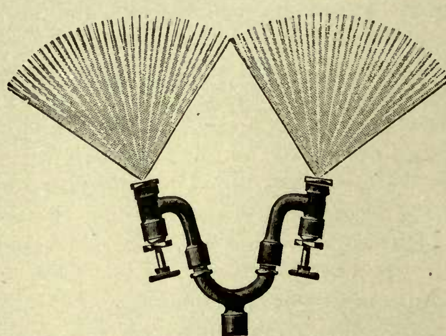
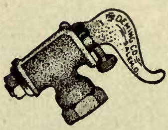


Fig. 86.—Double Vermorel nozzle with Y connection.

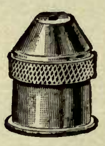


A. Bordeaux.

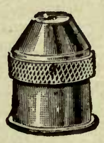
B

B[1]. Disc type adjustable.

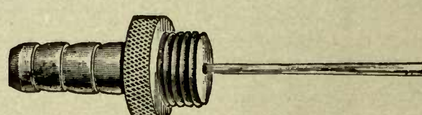
C. Two B type attached to a Y, adjustable to any angle.



D. Fine spray.



E. Coarse spray.



F. Solid stream nozzle.

Fig. 87.—Collection of nozzles.

little or none. Should one be using Paris green in a liquid from a bucket, this should be borne in mind, and the liquid almost constantly stirred.

Tanks for Field Use.—These can be made of galvanized iron or pine, cypress or cedar. The last is said to be the best of the woods for this purpose where obtainable. When made of wood, the inside should be painted. Tanks vary greatly in size. Two horses cannot comfortably draw more than 250 gallons of liquid over the field.

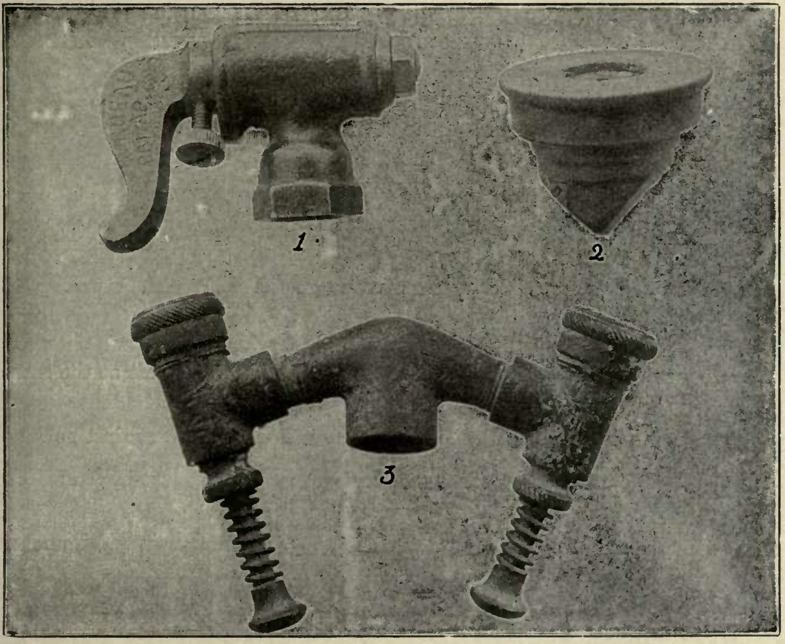


Fig. 88.—1. Bordeaux nozzle. 2. Disc type of nozzle; and 3. Double Vermorel. Britton and Clinton. Report of Conn. Station, 1911

Knapsack Sprayers.—These are machines intended to be carried around on the person's back, or lifted about by hand when desired. They are excellent for work with shrubbery or in garden where too much ground is not to be covered. The writer speaks from personal experience when he says that after several fillings, the weight tells upon one's back and shoulders (Fig. 73).

Dust Sprayers.—The simplest form of dust sprayer is found, perhaps, in the little bellows sold at drug stores, and used to dis-

tribute pyrethrum in cracks and crevices which might conceal fleas or bedbugs. A larger bellows is made for use with plants, and a still more complete machine for field use is shown in figure 67. With these one can distribute lime or a mixture of lime and Paris green, dry Bordeaux and like material. More recently, at least two firms have manufactured dust sprayers on a larger scale, to be placed on wagons, and intended for use in large nurseries or orchards. One called the "Cyclone Sprayer," and made in Kansas City, is shown in figure 68. This machine and a smaller one made by the same firm are shown in use on pages 47 and 48. A dry Bordeaux and certain caustic compounds are used with these sprayers, or a combination of dry Bordeaux and Paris green is manufactured, though directions are given to purchasers whereby many of these compounds may be made at home.

QUESTIONS

1. What two practical divisions of insects can be made by the farmer and orchardist, independent of scientific classification, and what bearing have these upon the use of insecticides?
2. Describe Paris green and its uses. How can one distinguish between good and bad Paris green?
3. Describe and discuss the use of arsenate of lead.
4. Why is the use of London purple undesirable?
5. How can we treat a tree for a plant disease and insect pest at the same time?
6. Describe poison baits and their uses.
7. Name in order of importance three insecticides for use against sucking insects.
8. What are some of the leading mechanical measures against insects?
9. Enumerate the uses of tobacco derivatives in sprays.
10. What is the chief objection to the use of kerosene emulsion?
11. Give a recipe for a preventive wash to apply to the trunks and branches of fruit trees.
12. Compare liquid and dust spraying.
13. What points are to be desired in a spray pump, and what features are to be avoided?
14. Discuss nozzles, good and bad.

CHAPTER VI

FUMIGATION

Fumigation, in entomology, consists of the application of poisonous gases to kill insects. Disregarding a discussion of benzine derivatives, the use of which is yet in the experimental stage, we find available for use in fumigation the following: Tobacco—discussed before; sulfur, either in powdered form or in the shape of "candles"; formaldehyde—of little or no value against insects; carbon bisulfid, and hydrocyanic acid gas. The last two deserve most careful consideration as being of the greatest economic importance.

Carbon Bisulfid.—A cheaper grade is known as Fuma. The commercial grade is excellent for use against clothes moths, buffalo beetles, and insects infesting stored grain or seeds. It has a most striking odor, that of the pure article reminding one of ether, the poorer grade like that of decaying eggs. The gas generated, when mixed with air, is highly inflammable; it is heavier than air, and is thus adapted to sinking down among furs, woollens and grain. If breathed for any length of time, it gives rise to unpleasant symptoms, and may, if inhaled to excess in a closed room, cause sickness and even death. It is not, however, as dangerous in this connection as hydrocyanic acid gas. It is evident that no light of any kind should be brought near bisulfid of carbon when employed as a fumigant.

How to Use.—Commonly, it is used at the rate of two pounds of the liquid for every 1000 cubic feet of space when the temperature is about 70° F. In actual use against the Angoumois grain moth it has been found that six pounds for each 1000 cubic feet are necessary. The granary, bin, room, chest, barrel, or jar must be made as nearly tight as possible, and when the liquid is used in quantity it should be placed in shallow dishes or pans to facilitate evaporation. The higher grade will not injure clothes, and in any form it will not affect the germination qualities of seed or render any product unfit for human food. Its various uses are discussed in the following chapters, under the heads of the insect pests against which it is employed.

Treating Grain in Bins.—In using this on stored grain, the

liquid may be poured directly on the grain. The bin or warehouse is to be first made as tight as possible; heavy sackcloth may be placed on top of grain in the bin. If the bin is very deep, a gas pipe with the lower end plugged, and with holes drilled in the side to allow escape of liquid, may be thrust down into the grain. This aids in distributing the insecticide at different levels. Two pounds of liquid for every one hundred bushels of grain, or two pounds for every one thousand cubic feet of space are advised. The process should last over night. The building or bin should be well aired afterward. Workmen should be cautioned against using lighted cigars or pipes, or lights of any kind, during their work with this agent or while ventilation is in progress.

Hydrocyanic Acid Gas.—This is made by uniting cyanide of potash or cyanide of soda with sulfuric acid (H_2SO_4). Unlike the preceding, this gas is lighter than air. It is not inflammable nor explosive at the strengths used by entomologists, but is most deadly in its effects upon man or animal if inhaled. In the hands of an expert, it is a safe agent, for knowledge of its dangerous qualities results in intelligent precautions in its use. The odor of the gas is much like that of peach pits, and the slightest trace of such an odor constitutes a warning.

As an insecticide it is far superior to bisulfid of carbon, in that it is fatal to all stages of most insects, including the egg stage. Only the chemically pure cyanide should be used (98 per cent), and sulfuric acid of a specific gravity of 1.83 or over. Cyanide of sodium may be used in place of cyanide of potash if the latter cannot be obtained, but should be fresh, and it calls for one-half more acid than does potassium cyanide. For example, the standard formula for every one hundred cubic feet is one ounce cyanide of potash, one fluid ounce of commercial sulfuric acid, and three fluid ounces of water; if cyanide of soda is used the formula would be: Cyanide of sodium, one ounce; sulfuric acid, one and one-half fluid ounces; water, four fluid ounces. For the fumigation of orchard trees with hydrocyanic acid gas, see Chapter XI.

Fumigating Scions and Other Nursery Stock.—Many states require that nursery stock sold therein or brought within the state boundaries be fumigated. Nurserymen, therefore, should know how to conform to these requirements. In fumigating nursery stock, an air-tight box or room should be constructed, cubical contents of which can be easily figured. For every one hundred cubic feet of space use one ounce cyanide of potassium, two ounces

sulfuric acid, and four ounces of water. If cyanide of soda is employed, use three ounces sulfuric acid. The cyanide should be broken into lumps about two inches in diameter and placed in manila paper bags. Workmen should use gloves. Water should be placed in earthen crocks, large enough to prevent the liquid from boiling over, the acid added, pouring it gently into the water. The acid should never be poured into the jar before the water. This crock is placed in the center of the room or box, the trees or scions lying on racks above it. When everything is ready the proper charge of cyanide—contained in a paper bag—is dropped into the liquid and the box or room tightly closed. Exposure to fumes should last about one hour, the fumigation chamber then opened and allowed to air for fifteen minutes. Stock to be fumigated should not be wet. Fumigation of nursery stock is far preferable to "dipping." Where not practicable, however, stock may be dipped in oil emulsion or lime-sulfur, avoiding wetting the roots, or, better, it may be planted out and sprayed with these scalecides.

The greatest care must be observed in handling this poison and during the operation. In cleaning up, every particle of cyanide should be accounted for, and all tools and utensils employed made scrupulously clean. One should avoid inhaling the dust in breaking up the cyanide, and it should be kept out of sores or cuts in the hands. (For the fumigating of mills with hydrocyanic acid gas, see Chapter XVIII.)

Fumigating Granaries and Grain Bins with Hydrocyanic Acid Gas.—This is described on page 353. It is useful if bins are empty. For full bins carbon bisulfid should be used as directed under that head. Both processes may be resorted to for the same building, one following the other.

Fumigating Houses with Hydrocyanic Acid Gas.—This process is very effectual against bedbugs, fleas and ants. At the same time it is very dangerous, and every precaution must be taken to prevent accident. It should not be resorted to if other effective measures are available. The same general method is followed as given under fumigation of mills. All polished metal must be protected, rugs and carpets safeguarded against the boiling over or breaking of jars, and the house must be left unoccupied during the fumigation and ventilation. All moist foods should be removed. Fumigation of one apartment of a double house or apartment house would be attended with grave dangers to occupants of the other apartments. As pointed out elsewhere, in working with this gas, one should

keep below it, *i.e.*, begin to fumigate on the top story and work down, while in the use of bisulfid of carbon the reverse is necessary, and one can work for quite a long period in the fumes of the latter gas—until dizziness is felt.

Fumigation of Greenhouses with Hydrocyanic Acid Gas.—Excellent for mealy bugs, white fly, and aphids, but not practical for red spiders and scale insects.

William Moore, of the Minnesota Station, has done some excellent work in this direction, and we are privileged to quote from his report as well as from results attained by Whitmarsh, of Ohio, and Davis, of Illinois.

In the fumigation of greenhouses, there are a number of factors to be taken into consideration. The most important feature is to

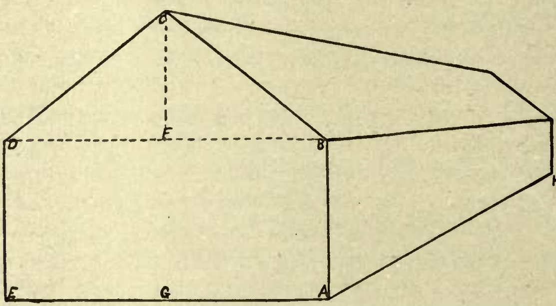


Fig. 89.—Diagram of greenhouse with two sides of roof equal.

have the greenhouse accurately measured, so that one can determine the exact dose of chemical which is necessary to kill the insect pests and not destroy the plants.

Contents of House.—Figure 89 shows a view of a greenhouse which has both the slanting roofs equal and the height of each side equal. Such a house is very easily measured and the number of cubic feet determined. In a house of this kind, the height *AB* is multiplied by the width *AE* and the result multiplied by the length *AH*. This gives the number of cubic feet of space in the rectangular portion *ABDE–H*. The upper portion is still to be estimated. For this purpose, take the height *CG* and subtract from it *AB*, the height of the side. This will give the height of the line *CF*. Multiply *CF* by the width *FB* (which equals *GA* or half *AE*). This will give the number of square feet in the section *BCD*. The number of square feet in *BCD* is multiplied by the length *AH*,

giving the number of cubic feet in the upper portion of the greenhouse, which, added to the number of cubic feet in the lower portion, gives the capacity of the greenhouse in cubic feet.

Many greenhouses have the sides unequal and the slopes of the house unequal, as shown in figure 90. In such a greenhouse, one must multiply the height *AB* by the width of the rectangular portion *ABIG*, which width is *AG*, *G* being a point immediately underneath the highest portion of the roof. The same is done for the rectangular portion *DEGF*. We then have two triangular portions still to compute. Multiplying *CI* by *IB* and dividing by two gives the number of square feet in the portion *CIB*. The same is done for the triangle *DCF:* that is, *DF* is multiplied by *CF* and divided by two.

The number of square feet in these four sections are then added together to give the sum-total of square feet in the end of the

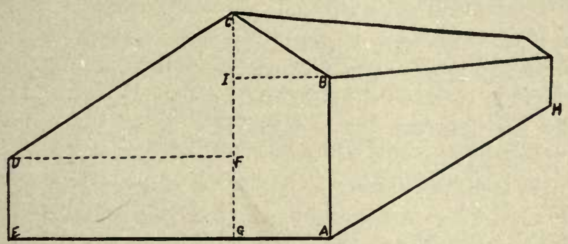


Fig. 90.—Diagram showing roof with unequal sides.

greenhouse. This sum is now multiplied by *AH* to get the cubic feet in the house.

Amount of Chemical.—After having carefully estimated the number of cubic feet, the next point to determine is the amount of the chemicals to be used. This varies according to the plants which are present. Some plants are more susceptible to cyanide gas than other plants, and where there are a number of different plants in the same house the amount of material to be used should be such that it will not injure the most tender variety.

Two other factors which are most important are the temperature and the humidity in the house. Plants are always more readily injured in a house where the temperature is low, say 60 degrees, than they are when the temperature is high, as, for example, 70 to 80 degrees. The more moisture in the house the more apt the plants are to be injured, so that the house should be just as dry as is possible, considering the plants which are in it.

Some plants can never be fumigated, or have never been successfully fumigated. Roses, carnations, and chrysanthemums can be successfully fumigated to kill aphids and white fly under proper conditions. The plants may even be in full bloom.

Plants should not be watered just before fumigation. In fact, it would be well if the plants had not been watered for twenty-four hours before the process. The temperature should be about 68 to 70 degrees, and the fumigation must be done at night; even on a cloudy day it is apt to burn the foliage, while some entomologists seem to think it advisable not to fumigate on a bright moonlight night. However, the moon does not seem to affect results. The materials used in fumigation with cyanide are potassium cyanide, sulfuric acid, and water. The usual formula is: One ounce potassium cyanide, two fluid ounces sulfuric acid, and three fluid ounces water. Some prefer to use as much as six fluid ounces of water to one ounce of sulfuric acid. The more water that is used, the slower the gas is generated and the more evenly it is probably distributed. The sulfuric acid is slowly added to the water, which is contained in an earthenware jar, constantly stirring. The earthenware jar is necessary, inasmuch as metal will be acted upon by the sulfuric acid. The resulting mixture will be hot, and the broken cyanide is added to it while still hot.

The dose which is in general use is from one ounce to five ounces of potassium cyanide per thousand cubic feet. It would be well to first try the lighter dose, and if the insects are not killed and the plants are uninjured, a stronger dose should be used. For overnight fumigation use one-quarter to one-half ounce per thousand cubic feet rather than a heavy charge for a short time. Under these conditions there will be no danger in airing out the following morning.

It would be well to advise the use of not more than one-quarter of an ounce for the first dose to each thousand cubic feet for overnight use, and not more than three ounces per thousand cubic feet for fumigation for a half hour. If either of these doses is used, and the insects are not killed while the plants show no injury, the amount of cyanide per thousand cubic feet could be increased, but not exceeding five or six ounces per thousand cubic feet as a maximum quantity.

Precautions.—The gas is extremely poisonous, as is also the case with the potassium cyanide. For that reason it is best not to be in the house at the time that the cyanide is to be placed in the jars. This can be arranged by putting the cyanide in bags tied to a string suspended from the ceiling, end of the string to be

extended to the outside of the house, so that the cyanide can then be lowered into a jar while the person is on the outside of the house.

When a large greenhouse is to be fumigated, it would be well to have several jars, so that the gas will be thoroughly distributed throughout the greenhouse.

If heavy bags are used for the cyanide, the jars can be placed in order and a bag placed beside each jar. When all is ready, move rapidly along the row of jars, placing the bags in the acid, and leave the house at once.

Ventilators should be arranged in such a way that they can be opened from the outside to air the house.

One should be careful to remove cats or any other pets from the house before the fumigation is started. If the cat is forgotten, one should not go into the house to get it after the cyanide is started; in fact, under no circumstances should the house be entered after the fumigation is started until such time as the house has been thoroughly ventilated.

Directions for Using Sulfur.—Rooms should be made tight by stuffing all cracks or pasting paper over them. Iron, steel and nickel are also attacked by sulfur fumes. Nickel fittings and gilt frames, copper, silver and steel utensils should be removed, though metal may be protected by smearing it with vaseline. Use two to three pounds of sulfur for every thousand cubic feet. Place vessel holding sulfur in a larger dish of water. A half pint of wood alcohol mixed with the above amount of sulfur will cause same to burn freely; or sulfur candles may be used.

Heated Rooms.—Most insects, particularly those in mills, will succumb if exposed to a temperature of 123 to 125 degrees F. for several hours. Dean, of Kansas, first demonstrated this with mill insects, and where such temperature can be safely maintained in mill, warehouses, or dwelling it is recommended.

QUESTIONS

1. Describe the method of fumigating grain or seed with carbon bisulfid. What precautions must be observed?
2. Describe methods of fumigating a greenhouse with hydrocyanic acid gas and tell what precautions should be observed.
3. How is nursery stock fumigated?
4. Give directions for the use of sulfur as a fumigant.
5. Enumerate the dangers in the use of hydrocyanic acid gas and tell what precautions should be observed in its use.
6. In what ways is fumigation with bisulfid of carbon dangerous and what precautions are to be observed?
7. What are the qualifications of a good spraying outfit?
8. What precautions are necessary in preparing and applying a liquid spray?
9. What are the objections to spraying fruit trees while in bloom?

CHAPTER VII

INSECTS INJURIOUS TO THE APPLE

THE apple is so universally grown and is such a valuable addition to our food supply that conditions surrounding its growth have been perhaps more carefully studied than those of any other tree, and the various insect pests attacking it have been the subject of careful investigation on the part of entomologists. The results of some of this work are given in this chapter.

INSECTS ATTACKING THE TRUNK AND BRANCHES

The Flat-headed Apple Tree Borer.—The adult is a broadly-flattened, metallic bronze-colored beetle (*Chrysobothris femorata* Fab.). It is about two-thirds of an inch in length, with short antennæ, conspicuous eyes, and a more or less ornamented back. The males are smaller than the females (Fig. 91). It is frequently seen during the spring and summer months, first appearing in May or June upon the trunks of the trees.

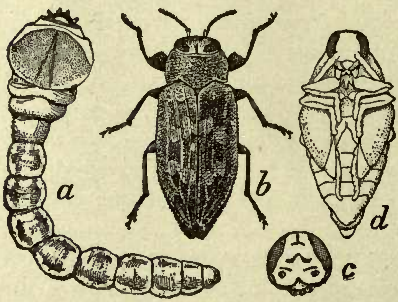


FIG. 91.—Flat-headed apple-tree borer. (U. S. Bu. Ent.)

Life History and Habits.—The female oviposits in cracks or under the bark. Diseased or dying trees are preferred. It attacks both fruit and forest trees, notably young trees. Sometimes maple trees may be infested. The eggs are yellow and usually several are grouped together. The larva is large, legless, and with a broad, flat head. It works into the wood, digging irregular flat channels, sometimes completely girdling a tree. Its presence is often indicated by sawdust-like excrement on the bark. The winter is spent in the larval stage, possibly occasionally as pupa. Ordinarily it pupates in the spring, just under the bark—the pupal stage being very short, approximately three weeks. When the adult beetle emerges from the trunk, it leaves an elliptical hole in the bark, while the hole left by the following borer is round.

Control.—Encourage the presence of woodpeckers. Cut borers out when discovered, if possible, without seriously injuring the tree. Place limbs in the sun around the orchard to attract the beetles during the egg-laying period. Burn this infested wood the following fall or winter. Practice clean culture and proper pruning. Plant healthy stock. See also remedies for round-headed borer.

The Round-headed Apple Tree Borer.—(*Saperda candida* Fab.). —The adults have two dorsal white lines on the back (Fig. 92).

Life History and Habits.—Adults appear in spring and summer. Females oviposit in incisions in the bark made with the mandibles.

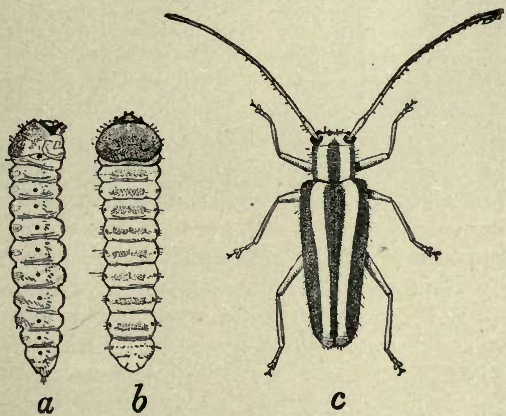


FIG. 92.—Round-headed apple tree borer; *a* and *b*, two views of the larva; *b*, pupa, *c*, adult. (U. S. Bu. Ent., U. S. Ag.)

The puncture is then closed with a gummy fluid. The pale-brownish eggs are placed singly. The time required for hatching is in doubt. The larvæ work inward and feed on the sap wood, working up and down the tree. After resting during the winter, they resume action in the spring. They work into the heart wood during the second season, spending their second winter as larvæ, and entering the pupal stage during May and June. They emerge as adults about two weeks later. Two years, therefore, are required to reach the adult stage.

Control.—Cut out larvæ when possible. To prevent egg-laying in the bark, paint the trees in the spring with a mixture of soft soap and carbolic acid. Boil one quart of soft soap or one pound hard soap in two gallons of water; then add one pint

of crude carbolic acid. A little Paris green and lime will make the mixture more valuable. Wrap the tree-trunks with paper in the spring. Paint the trunks with strong whale oil soap wash; or paint with good, so-called "tree paint" which is made up with water, not oil. A very good wash for tree-trunks on larger branches is the "government whitewash." The recipe is as follows:

Government Whitewash.—Slake half a bushel of quicklime with boiling water, keeping it covered during the process. Strain it and add a peck of salt, dissolved in warm water; three pounds of ground rice put in boiling water and boiled to a thin paste; half a pound of Spanish whiting and a pound of clear glue, dissolved in warm water; mix these together well, and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace; and when used, put it on as warm as possible, with painters' or whitewash brushes.

The San José Scale (*Aspidiotus perniciosus* Comstock).—This very destructive scale attacks all parts of the tree above the ground. The scale is frequently seen on fruit or young twigs accompanied by a red discoloration around each scale. It imparts a grayish, roughened appearance to the bark when very abundant.

Life History and Habits.—This insect spends nearly all of its life under the scale; is active only as a young larva and as a mature winged male. Both sexes hibernate when half grown under the scale. Males reach maturity early in the spring, fertilize the females, and disappear. Later, the latter give birth to living young. There are probably four generations in a year in favorable localities. The young larva, yellow in color, moves about to find a suitable place to attach itself. When about to become stationary, the scale is formed—the insect becoming covered with it in two days. The young scale is whitish, turning darker with age. The scale of the female is convex, with a yellowish and shining nipple in the center. The first moult occurs when the scale is twelve days old, after which males and females take different form. The scale of the male is smaller than that of the female and somewhat elongated, the nipple being near one end. The females pass the second moult when about twenty days old, becoming adult at the age of thirty days (Fig. 93).

This pest spreads quickly on nursery stock by blowing from tree to tree, and is also carried upon the feet of birds and on the bodies of large insects. The English sparrow has been recently shown to be a prominent means of dispersal.

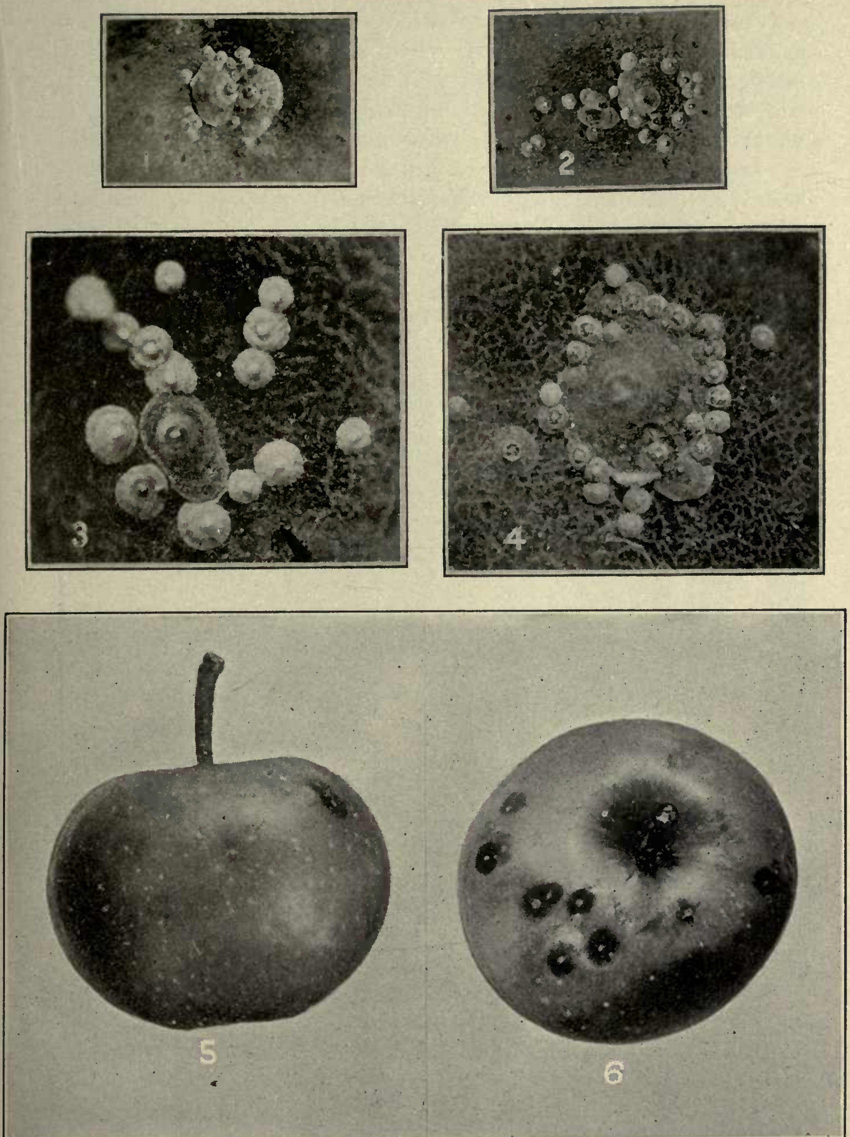


Fig. 93.—San José scale. 1, female scales, nipples lateral; 2 and 4, adult females with young; 3, male scale; all much enlarged. 5, adult female scale, natural size on apple; 6, discoloration of fruit by growing scales. (After Hall, Lowe and Parrott, N. Y. (Geneva) Bull. 193 and 194.)

Control.—Spray the trees twice—once as soon as the leaves are fallen, and, second, in the early spring, as soon as the buds swell. Use lime-sulfur wash each time. The old rough bark on the trunk of the tree should be scraped off before applying the winter spray, so that every portion may be wet with the liquid.

Lime-sulfur Wash.—Lime, four pounds; sulfur, three pounds; water, ten gallons; or, better, purchase commercial lime-sulfur and use according to directions on can.

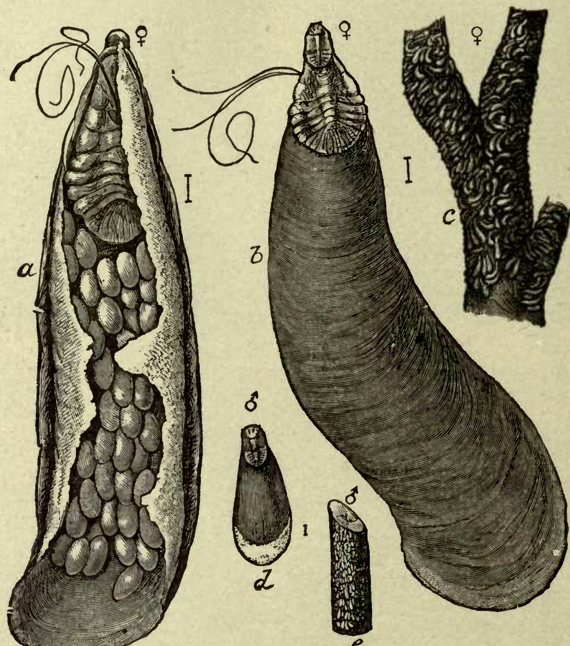


FIG. 94.—Oyster-shell scale or bark louse: *a*, female scale from below filled with eggs; *b*, same from above; *c*, infested twig; *d*, male scale; *e*, twig infested with male scale. (U. S. Bu. Ent.)

Summer sprays are hardly effective and should be resorted to only when winter spraying has been neglected. Dilute lime-sulfur (see directions) or whale oil soap (one pound to four or five gallons) or dilute miscible oils may be used at this season.

The Oyster-shell Scale (*Lepidosaphes ulmi* Linn.).—These have been introduced from Europe. The scales are one-sixth of an inch long, brownish in color, and are somewhat like the shell of the oyster in shape. The white eggs are found under the scales in winter,

Life History and Habits.—They hatch in May or early June. Like the preceding species, the young seek new locations on the same tree, and, becoming fixed, insert their beaks in the bark. The complete scale excreted from the body of the insect gradually covers it. By the middle of August the female scale has become transformed into a mass of eggs under the scale, and, day by day, as these are laid, her body shrivels until, finally, it becomes scarcely noticeable at the end of the scale. Male scales are smaller than the female and are seldom seen (Fig. 94).

The young scale retains the power of motion only a few days after hatching, and does not spread far, if nothing intervenes to help it. It may be spread by being carried on the feet of birds or large insects, and nursery stock should be carefully examined for it. It is a striking fact that a tree may be thickly covered with this scale and yet not seriously suffer, while a half or a quarter of that number of San José scale insects, if present, will cause the death of the tree.

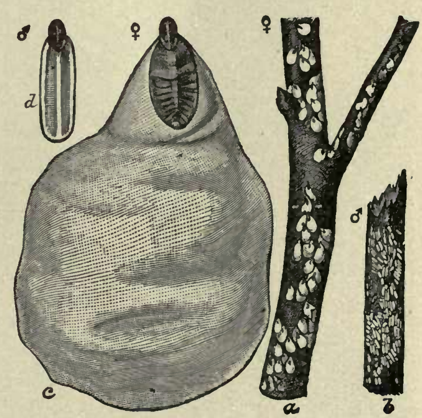


Fig. 95.—Scurfy scale: *a*, twig infested with female scale; *b*, twig infested with male scales; *c*, female; *d*, male.

Control.—Use lime-sulfur spray in the dormant season as with the San José scale.

The Scurfy Scale (*Chionaspis furfurus* Fitch).—This scale is quite common on apple trees. The female's scale is oblong, tapering to almost a point at one end; grayish white in color and about one-tenth inch long. The male scale is much narrower and smaller (Fig. 95). There is only one brood a year. The eggs are purplish-red in color. They remain under the old female scale during the winter and hatch in early spring. The young move a short distance on the trees and settle down permanently. The scale covering begins to develop soon after.

Control.—The lime-sulfur should be applied in late winter or early spring. The lime-sulfur solution does not appear to kill the eggs of this insect, and its application should be made just before the buds open in spring in order to catch the young larvæ. Or

we may use whale oil soap, one pound to four or five gallons of water. In June use the same remedies as given for San José scale.

For any scale, pruning of fruit trees should be practiced before winter or early spring treatment with sprays, in order that all parts of the tree may be better reached by the liquid. It is desirable to burn all prunings from infested trees.

The Putnam Scale (*Aspidiotus ancylus* Putn.).—This is not a serious pest, but is of considerable importance, because it resembles the San José scale so closely. In color it is dark gray. The female is circular and about one-twelfth inch in diameter. This differs from the San José scale in being slightly larger. It usually has a conspicuous or orange nipple a little to one side of the center, surrounded by a concentric depression less conspicuous than in the San José scale. Dispersal of this scale is less rapid than the last-named, and the injury caused is less severe. The young cluster more about the parent, thus making a more uneven infestation.

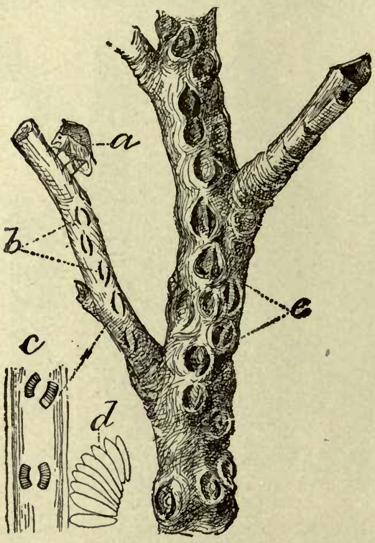


FIG. 96.—Buffalo tree hopper (*a*), infested twig and eggs (*c* and *d*). (After U. S. Bu. Ent.)

The insects pass the winter in the immature stage on the bark, completing their growth in the spring, at which time the two-winged males emerge. The females lay from thirty to forty eggs, late in the spring, under the scale. The fact that they are oviparous instead of viviparous is another mark distinguishing them from the San José scale. There is supposed to be but one generation.

Control.—Use lime-sulfur spray when trees are dormant.

The Buffalo Tree-hopper (*Ceresa bubalus* Fab.).—This is a jumping insect capable of strong flight. It is about one-third inch long, light-green in color, with whitish dots and a pale yellowish streak along each side. A sharp point upon each side of the front is seen jutting out horizontally, reminding one of a horn and suggesting the name. The body is three-sided and has been

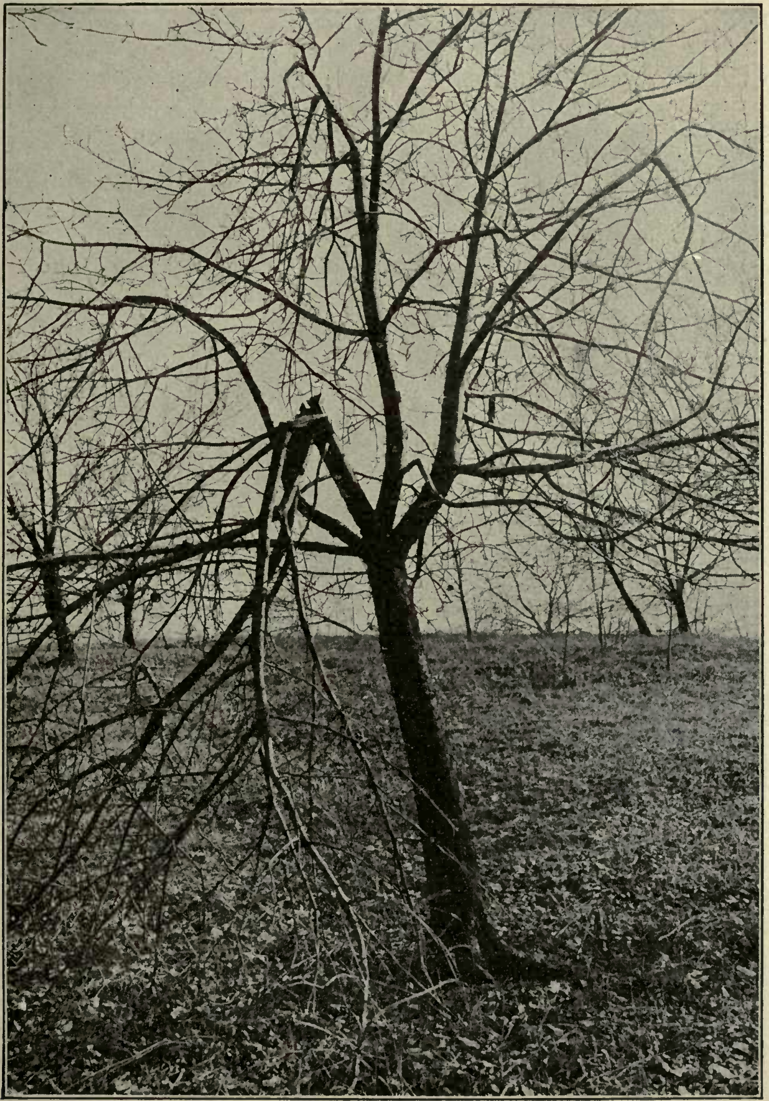


FIG. 97.—Branches of apple tree broken by over-bearing. In these the fruit-tree bark-beetle was found breeding in great numbers. (After Brooks, U. S. Bu. Ent.)

likened to a beechnut. The insect lives by sucking the sap through a sharp-pointed beak.

Life History.—Adults appear about the middle of May and continue egg-laying through August and September. The eggs are laid in two nearly parallel slits, each containing from six to

Fig. 98.—Woolly aphis on branch of young apple.

twelve eggs. These slits run lengthwise of the branch and are about three-sixteenths inch long, separated by about one-eighth inch of bark (Fig. 96). This provision is important, as the tips of the slits meet and cause a deadening of the wood, which prevents the eggs being crushed. Cold weather kills the adults, but the eggs winter in the branches, hatching in spring or early June.

Control.—Spraying specifically for this insect has not proved effective, even against the young hoppers, since these infest vege-

tation in proximity to the apple trees, but proper spraying for other insects would be of some service in checking attacks. Clean cultivation of the orchard is one of the best preventives.

The Fruit Bark Beetle (*Scolytus rugulosus* Ratz).—(Fig. 97.) See chapter on Plum, Peach and Cherry Insects, page 113.

The Woolly Louse or Woolly Aphis (*Schizoneura lanigera* Hausmann).—Bluish-white, flocculent, or cottony patches, wrapping clusters of the lice, are noted on the lower part of trunks or on branches of young trees (Fig. 98), particularly abundant on water-sprouts. There is a root form, also, which is more injurious (Fig. 99). This insect causes gall-like swellings in cracks of which it lives in clusters. A winged form also occurs during the season. The wingless lice are one-tenth inch long; reddish-brown, covered with characteristic cottony or waxy secretion.

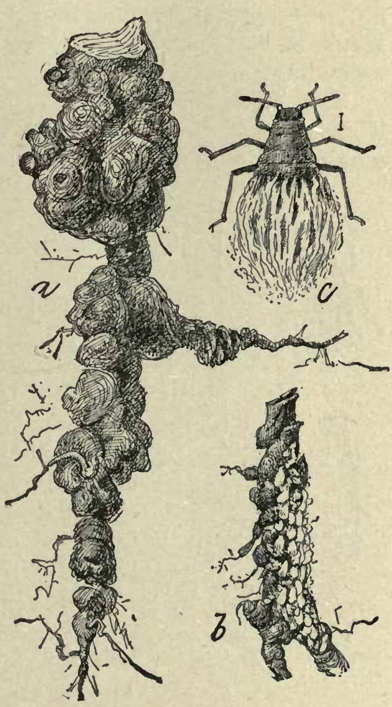


Fig. 99.—Woolly aphis, root form: *a*, deformed root; *b*, root covered with aphids; *c*, root louse, female, much enlarged. (Marlatt, U. S. Bu. Ent.)

Life History.—The woolly aphis lives over winter on the trunks and branches when the season is not too severe. The exact length of life of the adult is not known. Females give birth to living young for an indefinite period. The larvæ, when first born, have not the white secretion which soon appears when they begin to feed.

Injury.—As a result of the work of this pest, the bark becomes deeply pitted, or large cavities are formed. The tree ceases to grow at the point of attack. On roots it produces gall-like swellings. If abundant, the tree loses its vitality on account of the loss of sap, coupled, perhaps, by transmission of a poison by the insect. This insect is likely to be extremely abundant on any injured portion of the tree.

Control.—Dig up and burn badly infested trees, using ground for another purpose for a time. For the bark form of louse, use any of the washes recommended for plant lice, such as kerosene emulsion, strong soap wash, tobacco extracts, resin wash, etc., applied with sufficent force to penetrate the cottony cover. Sprays are best applied warm. Bands of tanglefoot about the base of trunk in early spring may keep many of the root forms from ascending.

The New York Weevil (*Ithycerus noveboracensis* Först.).—This is one of the largest of our snout beetles or curculios; at least a half-inch long; ash-colored, marked with black, with four whitish lines on each wing-cover, interrupted by black dots (Fig. 100). Three smaller whitish lines on the thorax; a yellowish spot on the back, at the junction of wing case and thorax. The larva or grub is footless, pale yellow, with a tawny head.

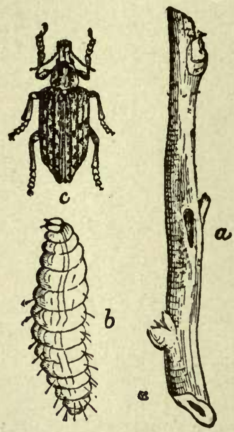


FIG. 100.—New York weevil, infested twig (*a*), larva (*b*), adult (*c*).

Life History.—The adult appears in May or June, the female depositing her eggs usually in oak or hickory trees. She usually makes a longitudinal incision with her jaws, eating under the bark; then turns and deposits her eggs in the opening. The larval stage is passed in the oak or hickory, and damage to orchards is naturally greatest near woodlands.

Injury.—The adult injures apple and other fruit trees by eating the buds and bark of twigs. Later, leaves are eaten off at the base. The beetle is active at night and prefers the tender, succulent shoots of the apple, but also feeds upon pear and plum, as well as peach in localities where the latter is grown.

Control.—Practice jarring of the trees as for plum curculio (which see). Spray with arsenicals early in the spring, just as the buds are swelling.

The Apple Twig Borer.—This insect is commonly found attacking the small twigs of apple trees. See the discussion under grape insects, pages 155 and 157.

INSECTS INJURING THE LEAVES

The Apple Tree Tent Caterpillar (*Malacosoma americana* Fab.).—The adult insect is a dull, reddish-brown moth with stout

body; and in the female a wing expanse of one and one-half to two inches; in the male, about one and one-half inches. In each sex there occur two nearly parallel, whitish lines running obliquely across the front of the wings.

The larva or caterpillar is two inches long when mature, cylin-

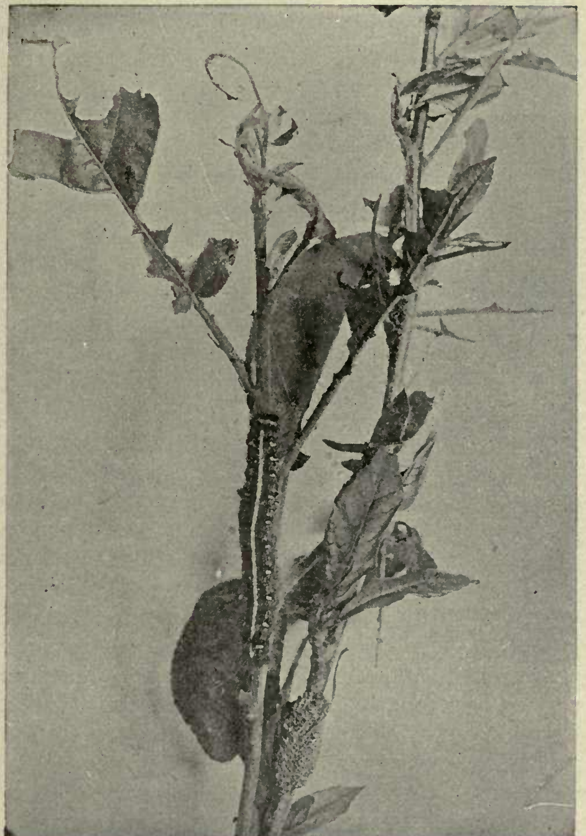


Fig. 101.—American tent caterpillar (Lugger).

drical, deep black with white stripe along the back and also with lateral markings; on each side, a row of oval, blue dots occur (Fig. 101). The body is sparsely clothed with fine yellowish hairs. The larvæ live in conspicuous nests made of layers of silk, frequently with room for the caterpillars between the layers.

Life History.—One generation is produced each year. The sexes mate soon after emergence and eggs are deposited on limbs and twigs. The female deposits from 150 to 200 eggs in early midsummer, the eggs encircling the smaller twigs (Fig. 102). These eggs stand on end and are covered with a waterproof coating secreted by the female. The caterpillars develop, but remain within the egg until the following spring. Upon the arrival of warm weather, they gnaw through the shells, often before the leaves come out. In that event they feed upon the glutinous covering of the egg mass (Fig. 102).

As stated above, the caterpillars live in silken nests or webs and feed on foliage at regular intervals—morning, afternoon, and night. The older caterpillars wander away from the nest and feed upon such plants as they find. They pupate approximately six weeks from the time of hatching, in any secluded place, under loose bark, in grass, or brush, under trees, along fences, and on the sides of sheds, houses and in other similar situations.

Fig. 102.—Egg mass of American tent caterpillar.

The pupal case or cocoon is composed of white or yellowish-white webbing, and the pupal stage lasts about ten days.

Control.—Remove all useless trees, such as wild cherry and worthless apple trees, growing along roadsides or fences. Destroy egg masses during dormant period of trees by pruning and burning the cuttings. Caterpillars, when they first appear, may frequently be killed by crushing with the hand. Later the nests may be burned. Arsenical sprays such as arsenate of lead are very effective against these and all leaf-eating forms of insects. Use two or three pounds of arsenate of lead in fifty gallons of water. This poison, when used as a spray against the codling moth or combined with a fungicide, easily keeps this pest in check.

The Tentless Caterpillar or Forest Tent Caterpillar (*Malacosoma distria* Hbn.).—This pest in the caterpillar stage somewhat resembles the previously discussed insect, with which it might be confounded. It does not, however, form a nest. The adult moth is yellowish-brown, with a wing expanse of one and one-half inches. It has two oblique, brown lines on the fore wings, enclosing a darker space.

The caterpillar is slightly smaller than the apple tent caterpillar. The general color is a pale blue, tinged with green on the

sides and everywhere sprinkled with black dots or points. There is a row of white spots along the middle, an orange-yellow stripe on each side of this row of spots. Below the yellow stripe is another cream-colored stripe, all stripes being edged with black. Each segment of the caterpillar has two elevated black points in the back from which arise a bundle of coarse hairs. The back is clothed with whitish hairs. The head is dark blue, freckled with black dots, also clothed with black and rufous hairs. The legs are black with whitish hairs (Fig. 104).

Fig. 103.—American tent caterpillars just hatched. Also egg mass on right. (Lugger.)

Life History and Habits.—The eggs are laid in the fall in rings around the twigs. The clusters of eggs are cut off squarely at the ends, differing from the egg-clusters of the tent caterpillar, which taper to the twig. There are from 200 to 400 eggs in each cluster, whitish covered with a brown, varnish-like substance. They hatch so early in the spring that the caterpillars have to wait for green food and have been known to live three weeks in quite cold weather without eating. When the leaves appear, they grow faster, and march over the tree in regular order. They feed twice a day. Wherever they go, they spin a thread, but do not make webs, nests, nor tent. Although gregarious when young (Fig. 105), the individuals spread when older and are seen wandering along fences, houses, roads, etc., in search of suitable shelter in which to change to pupæ. After two or three days, they transform to reddish-brown pupæ covered with short yellowish hairs. Moths appear about ten days later, deposit eggs, and die. This occurs in midsummer and only a single brood is produced in a season.

This insect eats foliage of apple, plum, fruit trees, and several of the forest trees.

Control.—Gather and destroy egg-clusters in winter. The larvæ are easily kept in check by poison sprays, preferably arsenate of lead. Spray with this compound as for the codling moth.

The Apple Leaf Aphis (*Aphis mali* Fab.).—This is a serious pest, particularly on young trees. The leaves, when attacked, curl up and may drop off.

Description and Life History.—The black winter eggs of these lice are frequently seen on the axils of the buds in late fall and winter. These eggs hatch in early spring, each egg producing what is

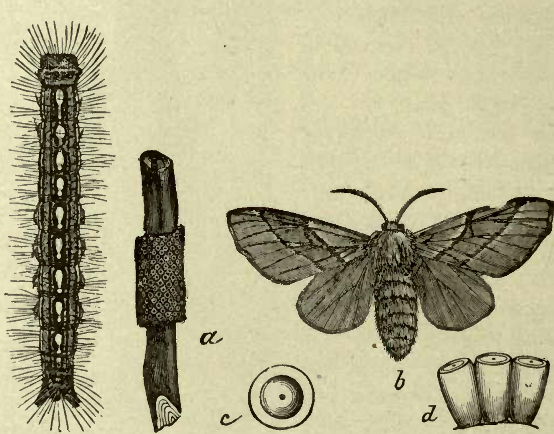


Fig. 104.—Forest tent caterpillar: *a*, egg mass (compare with egg mass of American tent caterpillar); *b*, moth, enlarged; *c*, top of enlarged egg; *d*, side view of three enlarged eggs. (After Riley.)

known as the "stem-mother," dark green in color. These stem-mothers work into the folds of the opening leaves, insert their beaks into the tissues, and feed upon the sap. In favorable weather they become adult in about two weeks and give birth to living young at the rate of from three to twelve a day for about three weeks, each stem-mother producing from 75 to 100 individuals.

These first insects are always wingless females. The following generations during the summer are all viviparous females. The second generation is slightly larger than the first. A small percentage of individuals of this generation are winged. Many of the third generation are winged, scattering to nearby trees to start new colonies. The wingless forms are larger and somewhat

more injurious than the winged forms. Late in the summer, winged forms become less numerous.

True sexual males and females are developed about September —the males being smaller than the females and both sexes smaller than the summer stages. After mating, the eggs are deposited on exposed surfaces of stems of apple trees. When first laid, the eggs are light green, later turning black, and remain unhatched until the following spring.

Control.—Late fall and early spring sprayings will help to destroy the eggs. Use lime-sulfur mixture according to directions on can; or use tobacco extracts. For summer sprays on living aphids, dissolve a five-cent cake of Ivory soap in five gallons of water; or of black leaf, No. 40, two tablespoonfuls, in a gallon of water; or one pound of whale oil soap in four gallons of water. When pruning, in the late winter or early spring, burn the cuttings to destroy the eggs thereon.

Fig. 105.—Forest tent caterpillars crowded together, greatly reduced. (Lugger.)

The Apple Bud Aphis (*Aphis avenæ* Fab.). —This is another louse, like the former introduced from Europe, found upon the apple. The eggs hatch in early spring on apple trees. The first generation or stem-mothers are deep green, wingless, and give birth to living young when mature, continuing to reproduce for three weeks. A few winged forms are found in the second generation, and a large proportion of the third generation are winged and migrate to grasses, grain, or oats. Several generations are produced on the grasses during the summer. Early in the fall the winged migrants go back to the apple trees and give birth to true sexual forms, the eggs being laid on the apple twigs.

Control.—Use the same remedies as for Apple Aphis.

The Apple Leaf Hopper (*Empoasca mali* LeB.).—This insect is not a serious pest in orchards, but retards nursery stock. It occurs in large numbers on plum, maple, burr oak, black oak,

thorn apple, basswood, hazel, box elder, blackberry, and many other trees and shrubs, but is particularly injurious to young apples.

Description and Life History.—The young form or nymph, when first hatched, is almost colorless, becoming pale-orange or greenish-yellow. It crawls to the under side of the leaves, is extremely active, and moves quickly when disturbed. It always walks, except in the last nymph and adult stages. The adults are about one-eighth inch long (Fig. 106). This pest is apparently two-brooded, the number of broods probably varying with the latitude.

The nymph emerges from the winter egg soon after the leaves open. It has five nymphal stages, twenty-two days being required to reach the adult stage. The adults lay summer eggs in petioles of clover, apple, and probably many other plants which furnish food during the summer. The adult stage lasts from two to four weeks. Where there are but two broods, the second brood deposits winter eggs under tender bark of apple tree or nursery stock. The presence of this egg is denoted by a blister-like swelling on the bark—less than one-twenty-fifth inch in diameter.

Control.—Collect the first brood with some sort of hopper-dozer on a shield smeared with tanglefoot. One pint of nicotine sulfate in one hundred gallons of water will control the young or nymph stages. Periodical dippings of affected tips of nursery stock, when insects first appear, in the same solution, are effective. Soap adds to the value of the above extract. Where convenient one should grow nursery stock as far as possible from orchard, as orchards seem to be infested yearly. Scions cut from infested orchards may help to spread the pest.

The May Beetle or "June Bug."—The adult beetles feed at night on leaves of fruit and shade trees, and the immature form or white grub frequently attacks the roots of the apple. See White Grub, under strawberries, page 135, for life history and control measures.

The Tarnished Plant-Bug (*Lygus pratensis* Linn.).—This insect begins its work in spring, feeding upon young buds, from which it sucks the sap. Its puncture seems poisonous and causes the leaves so attacked to wither and dry. Sometimes this bug attacks the fruit, causing deformities of the latter. It feeds upon almost all garden crops, small fruits, tender shoots of fruit and nursery trees, many flowering plants, and most of the common weeds.

Description and Life History.—The adult is brownish; about

one-fifth of an inch long. It varies somewhat in color from a dark-brown to a greenish- or yellowish-brown, the male being generally darker than the female. The head is yellowish, with three narrow, reddish stripes on top. The beak is about one-third as long as the body, folded underneath the insect when not in use. The thorax is yellow, margined with several yellowish lines running lengthwise. Upon the thorax is a yellow V-shaped mark. The wings are a dusky brown; and the legs are a dull yellow (Fig. 107). The young bugs or nymphs resemble their parents, but they lack wings and are more or less greenish in color.

The female deposits her eggs on leaves in the early spring, and later both young and old bugs are found together. The winter is

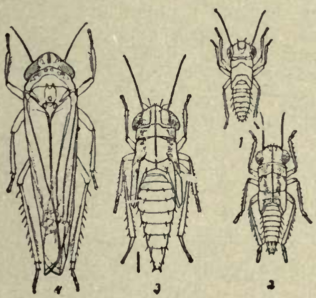


FIG. 106.—Apple leaf hopper: 1, 2, 3, nymphs; 4, adult.

FIG. 107.—The tarnished plant bug. (Lugger.)

passed in the adult stage among rubbish, etc. There may be two or three generations of this insect.

Injury.—This destructive bug attacks most garden plants, small fruits, tender shoots of fruit trees, nearly all of the flowering plants, and many weeds. It also punctures the young fruit of strawberries. Development is arrested when the bug sucks the sap.

Control.—Contact insecticides, such as tobacco extracts, soap solutions, etc., are used for the young nymphs. The adults are too active for effective treatment and, being sucking insects, are not affected by arsenical poisons. Clean cultivation and complete cleaning up of all rubbish and crop remnants are suggested. When the adults are plentiful they may be collected from the

trees with a net in the cool of the early morning. Lime-sulfur and Bordeaux mixture both form fairly good repellents.

The Lesser Apple-leaf Roller (*Alceris minuta* Rob.).—The caterpillars of this little moth fold tender leaves along the midribs or fold over the margins of older leaves and seek protection in the enclosure thus formed. Several young larvæ may tie up the tender unfolding leaves at growing tips and work inside, boring through the tender tissue and riddling it with small holes. Again, they may fasten two leaves together by their flat surfaces. The insect frequently injures young nursery stock.

Life History.—There are two forms of this species, an orange-colored moth, seen during spring and summer, and a slate-colored form observed late in the fall. The species has two broods. The wing expanse is about a half-inch. The larva is about a half-inch long, with yellowish head. In June, in many localities, and again in August, orange-colored adults appear. Pupation occurs on the leaves. The third brood, consisting of slate-colored adults, appears in October. The late forms hibernate among fallen leaves.

Control.—Pick off or pinch affected leaves on small trees or on nursery stock. Spray with arsenate of lead when the larvæ are very small or before they are hatched. If sufficient time is given them to fold their leaves, they are then protected from arsenical spraying. When moths are seen flying about, use this spray and repeat the same in ten days or two weeks.

The Bud Moth (*Spilonota ocellana* Schiff.).—The black-headed, greenish caterpillar—the young of this moth—feeds on the epidermis of the leaf, leaving a network of veins. It spins a small silken case just above the winter bud and hibernates therein when half-grown. In spring, when the buds open, it eats into the buds and young leaves, webbing up buds and clusters of leaves to make nests. The insects pupate in these clusters, the pupal period lasting about ten days. The adult moths appear in June, the transparent eggs being placed singly or in clusters. This insect is especially injurious to nursery stock.

Control.—Collect and burn the nests in spring or crush them with the hand. Early spraying with arsenicals as used for codling moth will help in their control. (See page 98.)

The Cigar Case-bearer (*Coleophora fletcherella* Fernald).—The insect hibernates as a half-grown larva in a case attached to a twig, emerging in April or May and attacking buds, leaves, and fruit. The case is built larger as the larva increases in size. In

this stage the insect mines a leaf and, discarding the old case, makes a new one from the upper and lower layers of the leaf. It becomes full grown in June or July, fastens the case to a twig, and pupates within. The pupal stage lasts ten days, after which the adults appear as minute gray moths.

Control.—Spray with arsenate of lead as in the treatment of codling moth. Repeat for five days. Kerosene emulsion used in place of arsenical poisons is effective. In connection with kerosene emulsion, note caution given in the chapter on insecticides.

The Spring Canker Worm (*Palecrita vernata* Peck).—The pale grayish female moth with dark brown stripe down middle of back and dark head is wingless; somewhat fancifully referred to as resembling a spider. The male is winged with a wing expanse of about an inch; wings semi-transparent; brownish-gray; three indistinct dark lines around the forewings.

When full grown, the larva is three-fourths of an inch long, cylindrical, with but one pair of pro-legs on middle of abdomen, and it walks by "looping." The color of the larva varies from ash-gray to green or yellow; the predominating color, however, is dark-greenish olive or blackish. It is marked with narrow, pale lines down the back and has a light stripe along each side.

Life History and Injury.—The moths emerge from their pupal cells in the ground in March and April. The wingless females then climb the trunks of trees. After the mating, the eggs are deposited in irregular masses of about fifty each on or under scales of bark, in cracks, crevices, and crotches of limbs and twigs. They hatch in approximately a month. The young caterpillars begin to feed on the expanding leaves, the larvæ when first hatched eating holes in the leaves and later eating the entire leaf except the midrib. They may drop from the tree and hang suspended upon strands of silk when disturbed.

The caterpillar becomes full grown in four or five weeks; enters the soil to a distance of two to five inches, hollowing out a cell in the ground, which it lines with silk. It then changes to a pupa which is about one-third of an inch long and light brown. The summer is passed in this condition.

Control.—Thorough cultivation during summer will largely destroy the pupæ. The caterpillars are easily destroyed by a spray of arsenate of lead, three pounds in fifty gallons of water. The first spraying should be given as soon as the trees leaf out, and the second as soon as the blossoms drop. The first is the more

important, and one good spraying is usually sufficient. The remedial measures recommended for the codling moth will also control these caterpillars.

The wingless females may be prevented from ascending trees by a tanglefoot band three or four inches wide. These bands should be applied late in March for the spring canker worm and

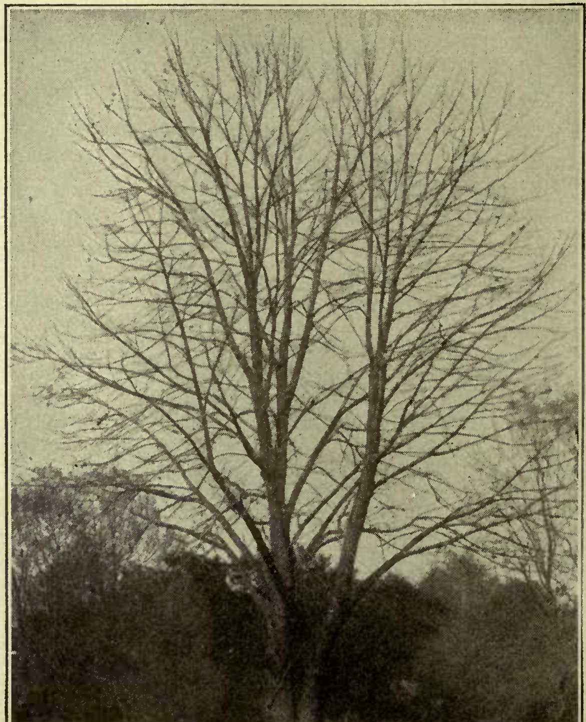


FIG. 108.—The fall canker worm attacks trees other than apple. A basswood defoliated by attacks of this insect. (Original.)

in late September for the fall canker worm. Before applying tanglefoot bands, the rough bark should be slightly scraped in order that no cracks are left untouched by this sticky mixture and that the compound may not be wasted. Personal observation leads us to believe that on very young trees it is safer to wind paper bands, two or three inches in width, about the trunk and apply tanglefoot bands on that, in order to avoid injuring the young bark. Do not tie these bands tight. Tanglefoot bands

should be kept sticky during seasons of infestation by "combing" with paddle or brush or adding new material.

The Fall Canker Worm (*Alsophila pometaria* Harris).—This measuring worm or "looper" also feeds on the foliage, sometimes stripping a tree completely. It not only attacks apple, plum, and other fruit trees, but is at times destructive to basswood and elm (Fig. 108).

Description.—The adult male moth, grayish or whitish in color, has fore-wings crossed by two light bands, the outer one indented on the front margin so as to form a distinct spot. This outer band is also seen on the hind wings, but less distinct. The female of this species is wingless and of a uniform, ash-gray color without markings. The segments are about as broad as long, without hairs.

The full-grown larva is from three-fourths to an inch in length, slender, cylindrical, with two pairs of pro-legs on the abdomen, which distinguishes it from the spring canker worm, the latter having only one pair. The color varies from ash gray to green or yellow, but the predominating color is dark greenish yellow or blackish. It is marked with narrow, pale lines down the back and a whitish stripe along each side.

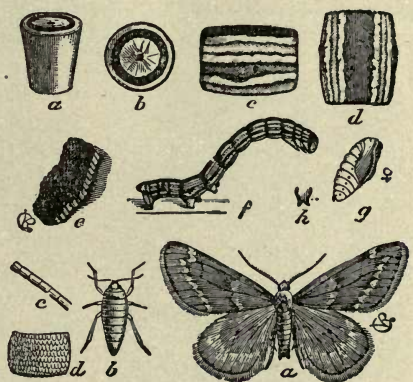


Fig. 109.—The fall canker worm. Above: *a*, *b*, single eggs, much enlarged; *c*, *d*, joints of caterpillar, much enlarged; *e*, egg mass; *f*, caterpillar; *g*, pupa of female. Below: *a*, male moth; *b*, female moth; *d*, one joint of same. (U. S. Bu. Ent.)

Life History.—The moths may emerge from the middle of September to as late as the middle of November, or even later—depending apparently upon climate and season—the eggs being laid in clusters of about one hundred in rows. These eggs are fastened on end on the bark of smaller branches or on the trunk. They are brownish gray, each something like a flower pot in shape, with a spot in the center and a ring on the outer end (Fig. 109). They hatch the following spring, in April, May, or early June. The caterpillars when full grown, in midsummer, pupate in the soil beneath the infested tree.

Control.—They are easily controlled by the usual arsenical

sprays or by the same mechanical barriers as advised for spring canker worms. Mechanical barriers, whether they consist of tanglefoot bands, or cotton, or wire netting, should be put in position as early as the middle of September for this species.

The Red-humped Apple Tree Caterpillar (*Schizura concinna* S. and A.).—These caterpillars are often found in great numbers on apple trees. When not feeding they are generally in groups. They feed on the leaves.

Description.—The larva of this moth, when full grown, is striped with yellowish white and dark brown or black lines and a double row of black spines extending along the back, which is marked with five narrow black lines. The first three segments are spotted black and white. The sides of the fifth to the tenth segments are whitish with black lines and five black points, and last segment is spotted with black. There is a prominent hump on the fourth segment, and this, with the head, is bright coral red, giving the caterpillar its name (Fig. 110). The caterpillar is one and one-fourth inches long when full grown, tapering towards the last segments, which are usually held in an elevated position.

FIG. 110.—Red-humped apple tree caterpillar. (Lugger.)

Life History.—Caterpillars appear in August, feeding upon the leaves, and in September they descend to the ground and construct a cocoon of silk mixed with particles of the surrounding rubbish. Here they pass the winter and emerge as moths in the spring or about the last of June. These moths have a wing expanse of about one and one-fourth inches. The general color is dark brown. The eggs are laid on the under side of leaves in late June or July, and there is one brood each year.

Control.—These caterpillars may be hand-picked or the colonies destroyed by swabbing them off the limbs with rags or waste saturated with kerosene. The tip of the limb containing a colony may be cut off and burned. The usual arsenical sprays as applied for codling moth would control this as all other forms of leaf-eating caterpillars. The young forms are more susceptible to poison than the mature insects.

The Yellow-necked Apple Tree Caterpillar (*Datana ministra*

Drury).—These caterpillars when young eat the under side or soft parts of leaves, leaving the veins. The older caterpillars devour all of the leaf.

Description and Habits.—When full grown, these caterpillars are two inches long; and are often seen in clusters on the twigs of the trees. They have jet-black heads. The head segment, which is often termed the "neck," is a bright orange yellow, and from this fact the insect is named. A black stripe runs down the middle of the back, and on either side of the body are three black stripes, alternating with four yellow stripes. The body is thinly clothed with long, soft, white hairs. If a limb upon which these caterpillars are found is jarred, the insects throw the head and tail in the air and may remain several minutes in this position (Fig. 111).

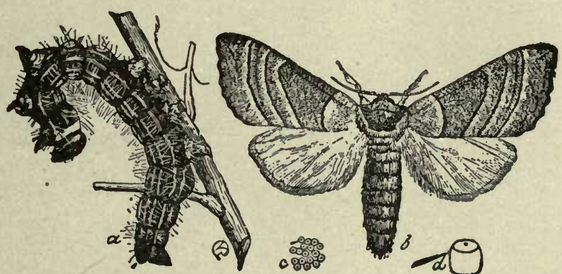


Fig. 111.—Yellow-necked apple tree caterpillar, larva, eggs, and imago. (After Riley.)

The female moth is reddish brown, has a wing expanse of about two inches, and lays from seventy-five to one hundred eggs in a cluster upon the surface of a leaf. The eggs hatch during the latter part of July and first part of August.

Control.—The colonies may be picked by hand and destroyed or swabbed off the limbs with rags or waste saturated with kerosene, as recommended for the red-humped caterpillar. If infestation is very serious, the tree may be sprayed with arsenicals while the larvæ are still small.

The Cecropia Moth (*Samia cecropia* Linn.).—This insect is a minor pest, but is conspicuous on account of its large size. It is easily controlled; yet a couple of caterpillars on a young tree, if unchecked, will strip it bare in a short time. This prevents the proper ripening of the wood for winter.

Appearance and Life History.—The full grown caterpillar is three or four inches long, is bluish green, and is covered with

tubercles. These tubercles on the third and fourth segments are red, while the others are yellow; and each tubercle bears a bunch of short, black spines. The tubercles on the last segment are blue.

The adult moth is one of our largest species, the wings having a spread of from five to seven inches. The body of the moth is furry. The head and thorax are rust red. The abdomen is red, with bands of white and black. The wings are grayish, inclined to brown, with cross-bands of white, black, and red. On the fore-

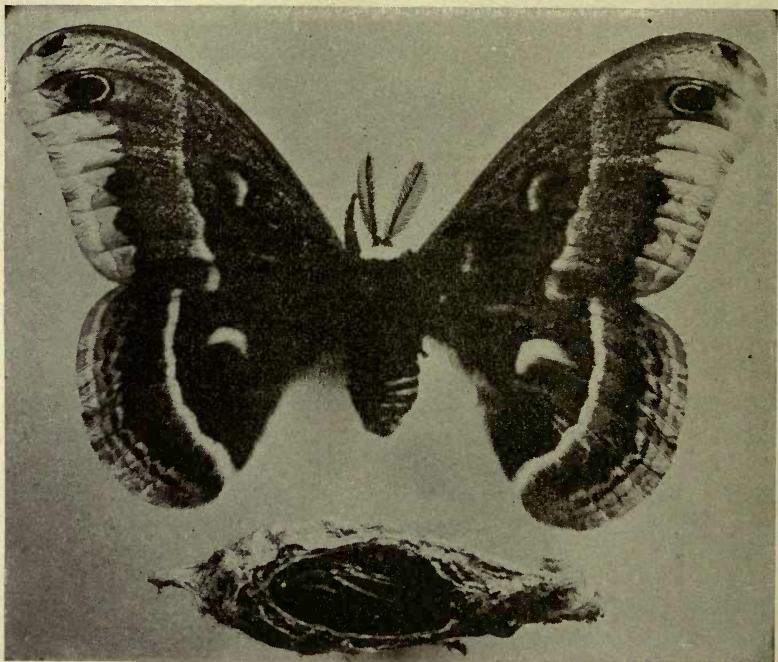


Fig. 112.—Cecropia moth, and cocoon opened to show pupa within. (Lugger.)

wings there is a purplish patch. A crescent of white bordered with red and black is on each wing. The wings are edged with clay brown, and are grayer on their under side (Fig. 112). The female moth lays lead-colored eggs on the upper side of the leaves in short rows.

The caterpillars, when first hatched, are black, with shining black knobs on their bodies, these knobs bearing black hairs. Their growth is very rapid and there are several moults.

Control.—Hand-picking of these large species is probably sufficient. They may also be controlled by arsenical sprays. In this connection, it might be noted that a fruit raiser, employing modern methods and spraying his trees in season with the proper compounds for the leading and most injurious pests, will control these minor pests at the same time, and hence the latter need no special consideration on his part. The grayish cocoons (Fig. 113) are easily seen on the bare trees in fall or winter, and should be destroyed.

The American Silkworm (*Telea polyphemus* Cram.).—This, like the preceding insect, is of minor importance as a pest, but its immense size makes it well known by many people. It is popularly known as the polyphemus moth. The larva attacks not only the apple and plum, but also such shade trees as maple, oak, elm, basswood, and others.

FIG. 113.—Cecropia cocoon frequently seen on bare trees in winter.

Description.—This large moth has a wing expanse of from five to six inches. It is buff-colored, but is sometimes inclined to pale gray or cream and again almost brown. The wings toward the base are crossed by irregular, pale, white bands margined with red. Near the outer margin is a stripe of pale purplish white, bordered with one of rich brown. About the middle of each wing is a transparent eye-like spot, with slender line across the center. The front edge of the forewings is gray. The moth flies only at night and is often mistaken, in the dusk of the evening, for a bat by the uninitiated (Fig. 114).

The caterpillar, when full grown, is over three inches long, with a thick, yellowish green body, having seven oblique pale yellow lines on each side. Its segments are well marked, and each is ornamented with tubercles, which may be tinted with orange, and each has a silvery spot in the center, and bears a few hairs. The head is pale brown. The terminal segment of the body is bordered by an angular point resembling the letter V (Fig. 115).

Life History.—When this larva is mature, it spins a silken cocoon inside an enclosure formed by drawing together a few

leaves. The cocoons may drop to the ground with the falling of the leaves or may remain on the trees during the winter. The

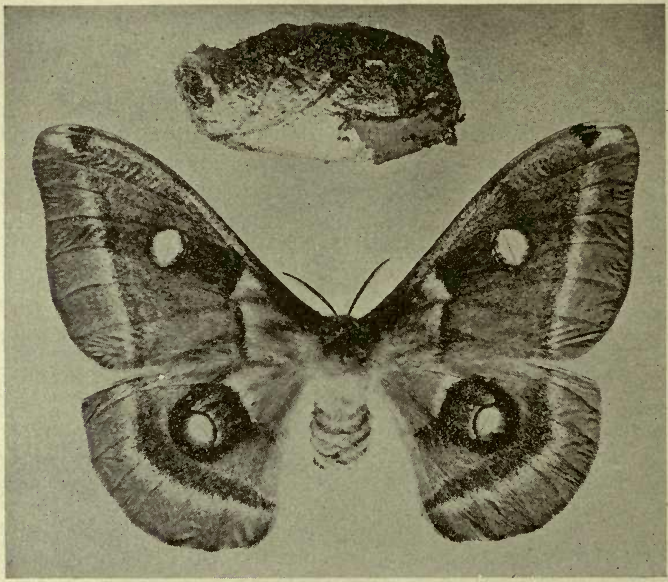


FIG. 114.—The polyphemus moth and cocoon, reduced. (Lugger.)

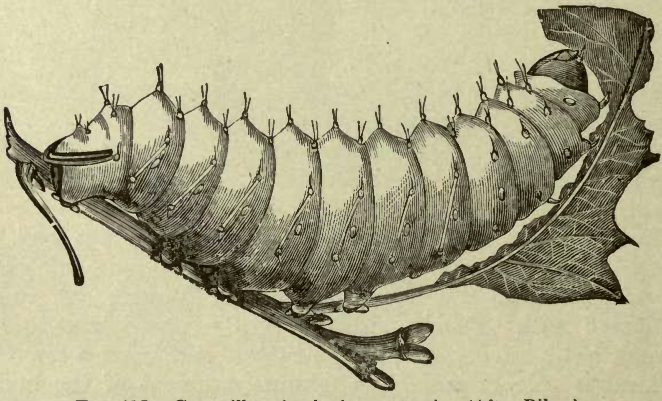


FIG. 115.—Caterpillar of polyphemus moth. (After Riley.)

cocoons of this species and also of the previous insect are conspicuous objects upon the leafless trees in winter. The adults emerge

from the cocoons late in May or in June, and the female, a few days after emergence, lays from two hundred to three hundred eggs on the under side of the leaves, usually only one or two on a leaf. From ten to twelve days are required for hatching.

Fig. 116.—A leaf-roller.

Fig. 117.—Larva of leaf-roller on leaf. (Herrick and Leiby, Cornell Bull., 367.)

Control.—Hand picking of the larvæ is probably sufficient. Insectivorous birds attack the larvæ. Parasitic insects, both Ichneumonids and Tachinids, are natural enemies.

The Fruit-Tree Leaf Roller (*Archips argyrospila* Walk.).—This insect is a general feeder on apple, pear, plum, cherry, and a host of other trees (Fig. 116). It has become one of serious importance. Primarily it is a pest of the apple, folding the young leaves and tying them together with silk, the larva feeding without this nest (Fig. 117). Then the blossom stems suffer, and later it gnaws the young fruit (Fig. 118). Much of this injured fruit never matures; that which does is deformed and is unmarketable (Fig. 119).

Fig. 118.—Work of leaf-roller larva on apples. (Herrick and Leiby, Cornell Bull., 367.)

Life History.—Eggs are deposited during the summer on bark of twigs. The caterpillars emerge the following spring. Pupation takes place within a folded or rolled leaf, the pupa lasting about eleven days. The moth, measuring about one inch from tip to

tip of expanded wings, is reddish, with two bright grayish spots on the front margin of each fore-wing. The insect is single brooded.

Control.—Miscible oils (one to fifteen gallons of water) sprayed once on trees in early spring, when the temperature is above freezing, will destroy the eggs. Two or more later sprayings of arsenate of lead (six pounds to 100 gallons of water), or of lime-sulfur solution, as directed for codling moth, and also directed against the latter insect, would be effective.

The Oblique-banded Leaf Roller (*Archips rosaceana* Harr.). —This small green or reddish caterpillar, three-fourths of an inch

FIG. 119.—Apples scarred and deformed by leaf-rollers. (Herrick and Leiby, Cornell Bull., 367.)

long, rolls up the leaves of the apple and lives and feeds inside. The adult is a brownish moth which emerges from the pupal form within the rolled leaves (Fig. 120). It is believed that the winter is passed in the egg stage—the eggs hatching in spring, with perhaps a second brood during the summer. The eggs are laid in clusters on the bark and are green in color. About one hundred and twenty eggs are laid by one female.

Control.—Lime-sulfur at the strength used for scale in the dormant spraying will prevent eggs from hatching. Trees may be sprayed also with arsenate of lead, three pounds to fifty gallons of water, when buds are swelling and again before the flower buds

open. These sprayings would also catch the bud moth larva, which is a serious pest.

The Apple-leaf Skeletonizer (*Canarsia hammondi* Riley).—This is a small, brown caterpillar, about one-half of an inch long when full grown. It feeds on the tissues of the leaves beneath the silk web, causing the leaves to look corroded and rusty. The larva is marked by four black dots just back of the head, two on the first segment and two on the second (Fig. 121). The pupal stage is passed on the leaf, and there are probably two or three broods during the season. The adult is a grayish moth with a wing expanse of one-half inch.

Control.—These caterpillars are easily killed with arsenical sprays. They are also attacked by several parasites.

The Well-Marked Cut-Worm (*Noctua clandestina* Harr.).—**Description:** The caterpillar of this species resembles somewhat other cut-worm caterpillars and its life history is more or less like that of other representatives of the family. When full grown, it is from one and one-half to two inches long. It is dull brown, gray, or blackish, often tinged with greenish, and is more or less marked longitudinally with dots and dashes. These markings are inconspicuous so that the caterpillars harmonize with the color of the soil. The head and thorax-plate are horny, and are reddish brown in color.

FIG. 120.—Oblique-banded leaf roller.

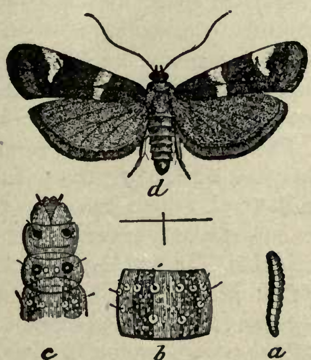


FIG. 121.—Apple-leaf skeletonizer: *a*, larva; *b*, segment of same, enlarged; *c*, anterior segments, enlarged; *d*, adult; hair lines below show actual size. (After Riley.)

The moth has dark fore-wings, gracefully marked with darker or lighter spots and narrow bands, and has lighter hind-wings. The moths, unlike others of this group, fold their wings over the back when at rest.

Life History and Habits.—The female deposits her eggs in July

or August on grass land or where a crop has grown up to grass. They are placed on stems or leaves of grass or on weeds, or even on stones or twigs. The caterpillars hatch in August and September, feed on whatever is available until frost. The caterpillars climb trees at night and attack the foliage, as well as living on the roots of various crops in the soil. They pass the winter in the caterpillar stage, and become full grown in the early summer of the year following; they then pupate and the adults emerge in July or August. There is usually but one generation a year.

Control.—Thorough cultivation of orchards is recommended. Clean up and burn all rubbish. Place cotton bands or tanglefoot around young trees to prevent climbing by the worms. Drop poisonous bait, such as poisoned bran mash (see chapter on Insecticides), in little bunches near base of trees. These caterpillars succumb to arsenical sprays. Young trees are the chief sufferers, but occasionally old trees are infested. Their attacks on young trees appear to be a strong argument against allowing sod in a young orchard.

The Bud Moth (*Spilonota ocellana* Schiff.).—The larva of this pest destroys young foliage and fruit buds, hibernating in small, oval, silken cases on bark of twigs. When the buds swell, the caterpillars bore into them and are thus protected from insecticides. Later they form nests by tying leaves together.

Life History.—They become full grown in June, transforming to pupæ in silk-lined nests. After ten days the dark ash gray moth appears, laying eggs singly or in small clusters on the under side of leaves. The eggs hatch and the young caterpillars feed on the epidermis of the lower side of the leaf, protected by a silk web. In the fall they migrate to twigs and there form cases in which they hibernate. When full grown the caterpillar is half an inch long, with a light chestnut brown color. (See also page 86.)

It is believed that this pest was introduced from Europe at least one hundred years ago.

Control.—Spray with Paris green or, better, with arsenate of lead just as the buds burst and again before the trees are in blossom. Here again the usual codling moth sprayings are effective.

The Leaf-crumpler (*Mineola indigenella* Zell).—Caterpillars of this moth build cocoons of silk, mixed with the dried excrement and borings of the worm. During winter crumpled leaves are found fastened to the twigs which, when separated, reveal the horn-shaped cocoons. Early in spring, when buds commence to ex-

pand, the caterpillars—not yet full grown—emerge and draw new leaves toward the cocoons. When full grown the reddish brown caterpillar is a little more than half an inch long. It matures a few weeks later, changes to a pupa in its case, and emerges as a moth two weeks later. There is but one brood annually.

Injury.—The caterpillars attack young apple trees in nursery and orchards, which are often seriously injured by the destruction of the leaves as they emerge from the buds. Green fruit and young bark are sometimes attacked. Other trees affected are quince, peach, plum, cherry, and sometimes pear.

Control.—Pick off and burn conspicuous cases in the dormant season. In extreme infestation, an early application of arsenate of lead, two pounds to fifty gallons, would be of value. Codling moth sprayings easily control this pest.

ATTACKING THE FRUIT

The Codling Moth (*Carpocapsa pomcnella* Linn.).—This well-known pest is believed to cause an annual loss in the United States of about $12,000,000; it originated in England.

Description and Life History.—The grayish brown moths, which fly only at dusk, have wings expanding about three-fourths of an inch. When closely examined, numerous lines of tiny gray and brown scales are observed. Near the rear angle of each fore-wing is a large, dark brown or coppery spot marked with streaks of brown and gold. The hind-wings are somewhat lighter, growing darker toward their margins (Fig. 122). The larva or caterpillar is the well-known, pinkish, somewhat fleshy "apple worm," three-fourths of an inch long when mature. It passes the winter in a cocoon in crevices of the bark, or in fruit cellars or fruit houses, wherever infested apples were found in the late summer and fall (Fig. 123). Before the time of blossoming, the larvæ turn into small brown pupæ, the moths emerging in two or three weeks. In from three to nine days the females deposit eggs, mostly on the foliage or in the calyx end of the small apple, each female averaging from eighty to ninety eggs. Hatching occurs in from five to ten days, depending upon the temperature, and the larvæ become full grown in from three to four weeks. Some of these larvæ may pupate and cause a small or partial generation. Most of them, however, hibernate during the winter and pupate in spring.

The young larva feeds at first either on the tender parts of the leaves or enters an apple. Those of the early brood, for the most

part, enter through the blossom end, and bore into the core (Fig. 124). The seeds appear to be very attractive to this pest. In three or four weeks the caterpillar is full grown and issues from the side of the apple, seeking a place for spinning its cocoon. If the

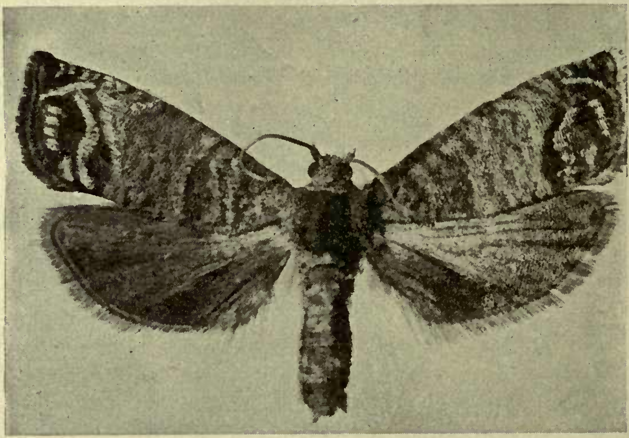


Fig. 122.—Codling moth, much enlarged.

apple is still on the tree, the larva lets itself down to the ground by a silken thread.

Control.—In the winter time woodpeckers seek out and devour the larvæ and cocoons beneath the old bark scales. These birds

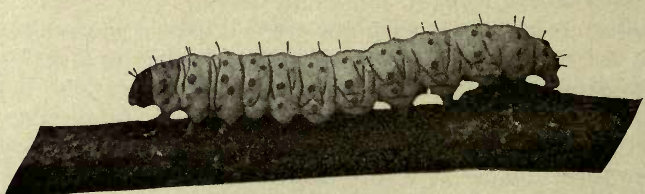


Fig. 123.—Codling moth larva, much enlarged. (After Slingerland.)

should be attracted to orchards by hanging up suet in the winter. All fallen fruit should be disposed of by the use of stock or gathered and destroyed in other ways.

The chief measure of control consists, of course, in spraying with arsenate of lead or with arsenate of lead combined with a fungicide, in order to control fungous diseases at the same time

(Fig. 125). Two or three pounds of arsenate of lead in fifty gallons of water or in fifty gallons of fungicide is recommended.

Spray with commercial lime-sulfur, one part to forty parts of water. Use two or three pounds of arsenate of lead for every fifty gallons of the mixture as soon as the first blossom buds begin to show pink. Repeat as soon as all petals have fallen (Fig. 126) and again three weeks later.

A later spraying should be given, toward the end of July. This treatment should control not only the codling moth but also the plum curculio attacking the apple, and all leaf-eating insects, as well as the apple-scab.

For oyster-shell scale a dormant spray (one part lime-sulfur to eight of water) might well be given earlier, when leaf buds are swollen, just before they open.

Fig. 124.—Proper time for first spraying for codling moth. The right-hand calyx closed; no chance to get poison in this.

The Palmer Worm (*Ypsolophus ligulellus* Hbn.).—This caterpillar may be primarily a leaf-eater, but, since it attacks fruit as well, it is included among the fruit insects. It injures apple trees in June and July, skeletonizing the leaves and fastening a few together by a web within which it feeds. It also eats irregular holes into the growing fruit and spins a web across the opening. It is extremely active, rapidly wriggling backward or forward and frequently hanging suspended by a web. The pupa is suspended by a web from the posterior end or rests between a few folded leaves. It changes to a moth in about ten days.

Control.—Spray trees with arsenate of lead as for codling moth.

The Plum Curculio (*Conotrachelus nenuphar* Hbst.).—This familiar beetle, more destructive to apples in some localities than the codling moth, is characterized, like other curculios, by the

presence of a prolonged beak or snout. It is about one-fifth of an inch long; color, mixed black, brown and white, with darker shades predominating. Several humps occur on its back, giving the dorsal surface a roughened appearance and affording it some protection on account of its resemblance to the bark on which it rests. The curved snout is about one-third the length of the body (Fig. 127).

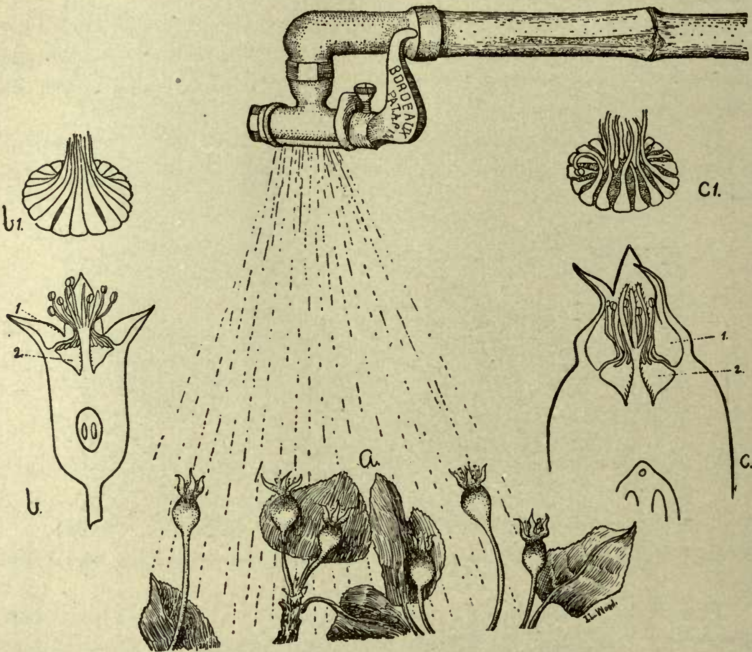


FIG. 125.—First spraying for codling moth forcing the liquid into calyx cup. Note that there are two cavities in the calyx cup, an upper and a lower (1 and 2 in *b*), separated by stamen bars (*b* 1). A few days after the petals fall, while the apples are still erect, these bars wither and separate (*c* 1), allowing the poisoned liquid to enter the lower cavity of the calyx. (*a* after Slingerland, remaining figure after Ball.)

Life History.—This beetle is sometimes called the "Little Turk," because the female, when the apples are no larger than peas, punctures them with her beak, introducing an egg into the puncture, and then cutting a crescent in the fruit at one side of the egg, preventing, it is believed, the growth of the tissue and the consequent crushing of the egg by so doing. This act on the part of the female beetle causes a distorted growth and the fruit would rank as imperfect.

The beetles leave their hibernating quarters in the spring, before

blooming time, seeking quarters in the trees. Egg-laying occurs during spring and early summer, when the old beetles die. The eggs, numbering anywhere from one hundred to five hundred from a single female, hatch in from three to seven days, and the grub normally feeds for from fifteen to twenty days in the fruit, at which time it leaves the apple or plum and enters the ground. It hollows out the soil and transforms into a pupa, in which stage it remains for about a month, then emerging as a beetle, going to trees and feeding on fruit, but does not lay eggs in the fall. Beetles

FIG. 126.—Blossoms from which the petals have fallen; in good condition to receive the spray. It is too late to apply calyx spray to two apples on left. (Gillette and List, Col. Bull., 210.)

also feed to some extent on the young buds in the spring, before the blossoms appear. Its work and life history in connection with the plum is practically identical with that in the case of the apple. Apples or other fruits infested with the larvæ, for the most part, drop to the ground. This allows the completion of the life history. It is claimed, however, that in much of the fruit which does not drop, the development of this pest is prevented. Many of the larvæ die before the larval stage is half completed, leaving matured fruit with the sunken scars on the surface as above indicated, and streaks of hardened tissue in the flesh.

Control.—Spray thoroughly with arsenical insecticides before leaves expand. Spraying for codling moth, after the petals fall, will aid in controlling the curculio. All fallen fruit should be destroyed. As an additional measure, the trees might be jarred every few days in the early morning, catching the beetles on a sheet

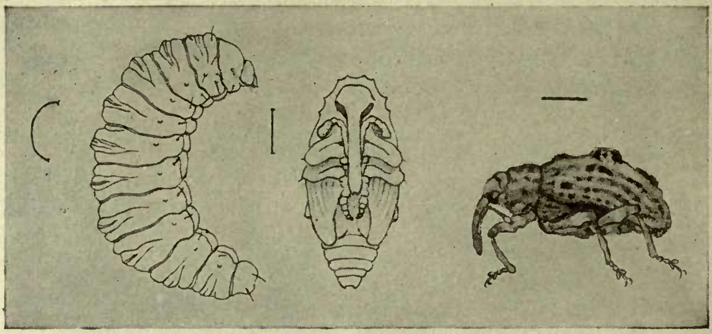


FIG. 127.—Plum curculio, larva, pupa, adult. Hair lines show natural size.

below and destroying them. The jarring is done before the adults lay their eggs on the young fruit.

The Apple Curculio (*Anthonomus quadrigibbus* Say.).—This is a small, brown weevil or curculio which comes out from hibernation quarters early in the spring, punctures the young fruit with

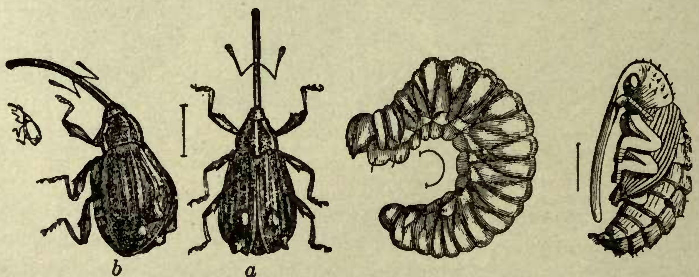


FIG. 128.—The apple curculio, larva, pupa and two views of adult. (After Riley.)

its beak, and deposits an egg in the puncture. The eggs are yellowish, oval in shape, and hatch in from four to five days. The period of greatest egg-laying is late spring and early summer. The native food is hawthorn and wild crab, but the insect is also fond of cultivated fruit, and from sixty to one hundred eggs are laid by a single female.

The larva or grub is white, legless, with a yellowish brown head and jaws, and is found burrowing and feeding near the center of the apple (Fig. 128). It becomes full grown in about twenty days, changing to a pupa in the center of the fruit and emerging as a beetle about ten days later. This emergence occurs during June, July, and August, and, after emerging, the insect feeds but little. The fall and winter are spent under leaves and rubbish beneath trees.

Fig 129.—Apple maggot fly.

Control.—Use the same methods as for the plum curculio.

The Apple Maggot (*Rhagoletis pomonella* Walsh).—The adult of this insect is a two-winged fly (Fig. 129). The general color is black, sides of head white, eyes green, antennæ orange. It is about one-fourth of an inch long, and appears early in the summer. The eggs are laid only in matured fruit, hatching in a few days. The larvæ make tunnels in the flesh of the fruit, working in all directions (Fig. 130). It takes from five to six weeks for the maggot to complete its growth. As a result of infestation, the fruit falls to the ground. The larva enters the soil, pupating about one inch below the surface. Frequently the maggots remain in the stored fruit. Adults appear the following spring, and there is but one brood a year.

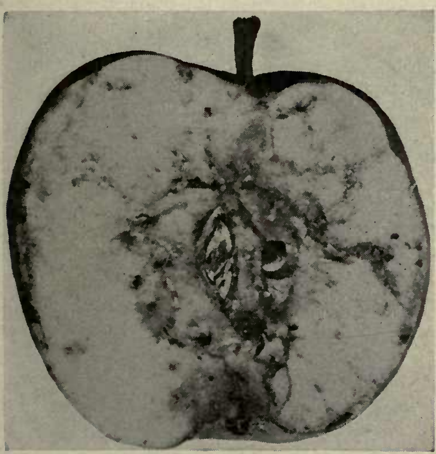


Fig. 130.—Burrows of apple maggot in soft fruit. (O'Kane, N. H. Bull., 171.)

Control.—Gather and destroy windfalls as soon as they drop to the ground. Cultivate orchards thoroughly.

Brown Fruit Chafer.—This brownish beetle is also called the

Indian Euphoria (*Euphoria inda* Linn.). It is about one-half of an inch long and is heavy-bodied. The wing covers are yellowish brown, marked with irregular darker patterns. The head and thorax are blackish, or a dark copper brown, thickly covered with short yellowish hairs. The under side of the body is black and hairy (Fig. 131). The beetle moves slowly and is not easily disturbed.

FIG. 131.—The Indian Euphoria. (Lugger.)

Eggs are deposited in manure heaps or decaying vegetable matter or in sod. In midsummer the grub changes to a pupa beneath the surface, the beetles emerging in the early autumn. There is one brood a year. The adults eat ripening apples and are sometimes also found on green corn.

Control.—Where troublesome, hand-picking may be resorted to, or the beetles may be attracted to a pile of decaying fruit and destroyed. This is not regarded as a serious pest, but is fairly abundant in localities.

Supplementary List of Apple Insects.—The following insects are more or less injurious to the apple. See page references.

Ash-gray pinion
Blind-eyed sphinx
Broad-necked Prionus
Buck moth or Maia moth
Cherry-tree scale, p. 127
Cottony maple scale, p. 287
Cucumber flea-beetle, p. 239
Emperor moth, p. 128
Eye-spotted bud-moth
Eyed elater
False chinch bug
Fasciated Lithacodes
Goat-moth
Gray dagger-moth
Hag-moth caterpillar
Imbricated snout beetle
Lime tree winter-moth, p. 284
Mottled plum-tree dagger-moth, p. 119
Oak pruner, p. 281
Pear blight beetle, p. 116
Resplendent shield bearer
Rose leaf-hopper
Slug caterpillar
Smeared dagger-moth
Stalk borer, p. 248
Two-horned tree-hopper
Thysbe clear-wing
Tiger moth
Trumpet leaf-miner
Unicorn prominent
Wild-cherry leaf miner
Zebra caterpillar of cabbage, p. 236

QUESTIONS

1. Enumerate the principal insects found on the apple tree in the following situations: trunk and branches; leaves; fruit.
2. Give life history of flat-headed apple tree borer and remedial measures. Give the same for the round-headed apple tree borer.

3. Give life history and remedial measures for San José scale. What are methods of controlling the oyster-shell scale?
4. Describe life history and measures of control of the woolly louse or woolly aphis of the apple.
5. Give life history and remedial measures for the tent and tentless caterpillars. What are the differences between these two species?
6. Give life history and measures of control for the apple-leaf aphis.
7. What remedial measures are suggested for the apple-leaf hopper?
8. Give life history of the fall web worm.
9. Compare the spring and fall canker worms. Give difference in life history and remedial measures for each.
10. Compare the red-headed and yellow-necked apple tree caterpillars.
11. Describe and give life histories of the Cecropia moth and the American silkworm.
12. Name a cut-worm which is sometimes an orchard pest, and give reasons.
13. Give description and life history of the tarnished plant bug.
14. Describe in detail the life history and habits of the codling moth, and best treatment for same.
15. Do the same regarding the plum curculio when it affects the apple.
16. In what way is the apple maggot injurious?

CHAPTER VIII

INSECTS AFFECTING THE PEAR AND QUINCE

A NUMBER of insects attacking the pear and quince are injurious also in the apple orchard. The San José scale, the twig girdler, and the codling moth have already been described under apple insects.

ATTACKING TRUNKS AND BRANCHES

The Sinuate Pear Borer (*Agrilus sinuatus* Oliv.).—This is a bronze-colored beetle, nearly one-third of an inch long, whose larva bores in trunks and branches of the pear, making tortuous passages in the sap wood. The presence of these borers is frequently indicated by a discoloration of the bark above. Since these burrows, if numerous, may result in the girdling of a tree, a large tree may gradually die as the result of an attack, and a small tree may be killed immediately.

The grub becomes full grown the second year, pupates in the tree, and emerges the following spring, the female at that time depositing her eggs in cracks of the bark. These beetles may frequently be seen basking in the hot sun on the trunks of the tree they attack.

Control Measures.—Dying or dead trees or branches should be burned. Repellent washes may be used as in the case of apple-tree borers. The grub may be removed from the burrow with a knife or killed therein by the use of a wire.

ATTACKING LEAVES AND FRUIT

Pear-tree Psylla (*Psylla pyricola* Forst.).—This insect was introduced from Europe about 1830. It is a brownish hemipterous insect, barely one-tenth of an inch long. Its abdomen has black bands. It has two pairs of wings, which, when the insect is resting, are folded over the back and against its sides in such a way that the insect is made to resemble a very small harvest fly or cicada.

Life History.—The adults hibernate under bark and rubbish, emerge in the spring, and lay their tiny eggs on bark or about buds. The scarcely visible yellow nymphs attack the petioles, fruit stems, and also the leaves (Fig. 132). It has several broods a

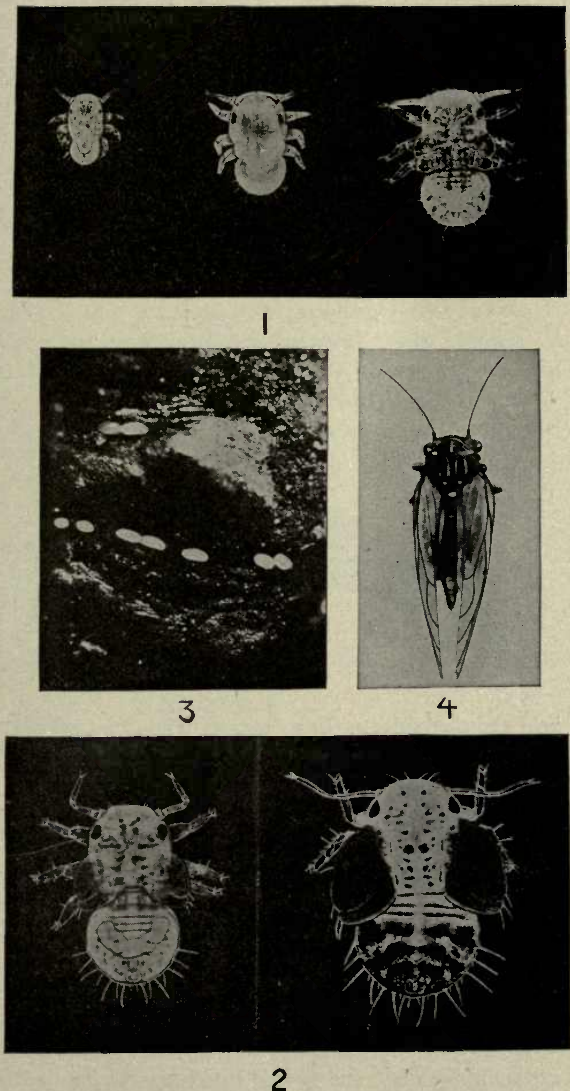


FIG. 132.—Pear psylla: 1 and 2, nymphs; 3, eggs; 4, winter adult. All much enlarged. (Hodgkiss, Geneva Bull., 387.)

year, and may at times cause severe injury in an orchard by weakening the trees and stunting the fruit. A sweet "honey dew" is secreted by them, which drops upon the leaves below, much in the same way as in the case of the hop aphis, and woolly louse of the alder, affording a fine culture for a black fungus, which gives a blighted appearance to the foliage.

Control Measures.—This insect may be kept in check by up-to-date orchard practice. Weeds and rubbish should be kept off the ground and the rough bark scraped from the trunks and larger branches. Spraying the trees on warm days in early spring with a tobacco extract will kill many. Use one pint of nicotine sulfate in fifty to seventy-five gallons of water, to which four pounds of soap are added. The dormant spray as used for scale will kill some, as well as the eggs of the first brood if present. Later, when nymphs are on petioles, the above spray of tobacco extract and soap may be employed, using it a little weaker (one pint of nicotine sulfate in one hundred gallons of water).

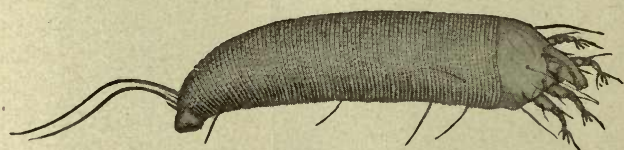


FIG. 133.—Blister mite. Greatly enlarged. (After Parrott, Hodgkiss and Schoene, Geneva Bull., 283.)

Pear-leaf Blister-mite.—Pear leaves with rusty blotches upon them are likely to be found infested with this tiny mite (Fig. 133) (not an insect), which lives within the leaf tissue. It is sometimes known as the plum gall-mite (*Eriophyes pyri* Pagen). See page 118.) The eggs of the mite are deposited within a raised blister or gall, which precedes the rust-like appearance above alluded to, the young migrating from one leaf to another. Young fruit may also be attacked.

Control Measures.—Spray in winter with lime-sulfur as practiced against scale insects.

Pear Blight Beetle (*Xyleborus dispar* Fab.).—The adult of this insect is a very small brownish beetle, one-eighth to one-sixteenth of an inch long, the round head nearly concealed by the thorax (Fig. 134). The female bores in small branches and twigs, causing the tips to die and to present a blighted appearance, hence the name of the insect (Fig. 135). The group of beetles to which

this one belongs is of wide distribution and is interesting because both young and old beetles feed on a fungous growth in their burrows, which is referred to as "Ambrosia."

Remedies.—If troublesome, an application of carbolic acid soap is said to give good results if applied in the spring. Use three gallons water, one gallon soft soap, one-half gallon crude carbolic acid.

Pear Thrips (*Euthrips pyri* Daniel).—These are minute brownish insects, which attack the buds of fruit trees, including the plum,

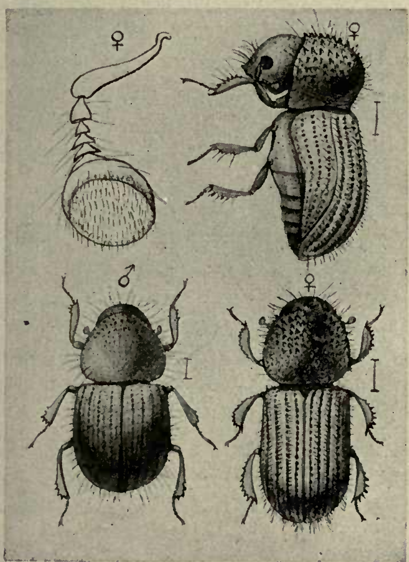


FIG. 134.—Pear blight beetle (*E. pyri*); adults and enlarged antennæ of female beetle. (Hubbard, U. S. Bu. Ent.)

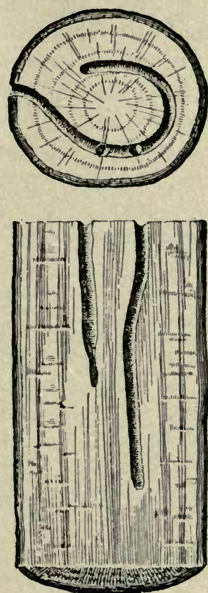


FIG. 135.—Gallery of pear blight beetle in poplar twig. Cross section above, longitudinal section below. (Marx, U. S. Farmers' Bull., 763.)

peach, and cherry. The adults are winged, but the young are wingless. They are white and have red eyes. Transformation takes place in the ground beneath the tree. Eggs are laid in fruit stems and in leaves and hatch in four or five days. The punctures made for the eggs cause the young fruit of prune and cherry to yellow and drop to the ground.

Remedial Measures.—From the above statement regarding its life history, it is evident that fall plowing and harrowing will

kill many of the nymphs in the soil. This treatment is said to be very successful in prune orchards of California. Two sprayings with nicotine sulfate, as recommended for the pear psylla, are advised. The first is made when the buds are on the point of opening and the second immediately after the petals fall. A whitewash spray is also used in California.

Quince Curculio (*Conotrachelus cratægi* Walsh).—Quince fruit is frequently made ill-shapen by attacks of this weevil. It works upon the quince in much the same way as the plum curculio works upon the plum and apple, but it does not make the crescent-like cut beside the egg puncture. Further, unlike its congener mentioned, it will develop even when the affected fruit does not drop to the ground. The white, footless grub burrows into the soil and remains in the larval stage until the following spring, transforming then to a pupa; and in ten or twenty days it changes to an adult. The latter is about one-quarter of an inch long, and is brownish gray.

Control Measures.—Destruction of windfalls and picking and destroying infected and misshapen fruit are recommended. Jarring beetles on to sheets spread below the trees is also practiced. The beetles are gathered up and destroyed.

The False Tarnished Plant Bug (*Lygus invitus* Say).—This plant bug looks much like the true tarnished plant bug, and injures the fruit by puncturing it. A spray of nicotine sulfate as recommended elsewhere in this chapter, immediately after all petals have fallen, is efficacious.

The Pear and Cherry Slug.—This slug attacks both the pear and the cherry. The discussion is given under cherry insects, page 129.

QUESTIONS

1. What insects affect the pear which are also found on the apple?
2. Describe and give remedial treatment for the pear-tree psylla.
3. The same for the sinuate pear borer.
4. The same for the quince curculio.

CHAPTER IX

PLUM, PEACH, AND CHERRY INSECTS

ATTACKING TRUNK AND ROOTS OF PLUM

A NUMBER of the insects attacking the plum, cherry, and peach trees have already been described in the chapter on apple insects. Reference should be made to that chapter for discussions of the New York weevil, the American silkworm, the plum curculio, San José scale, and others.

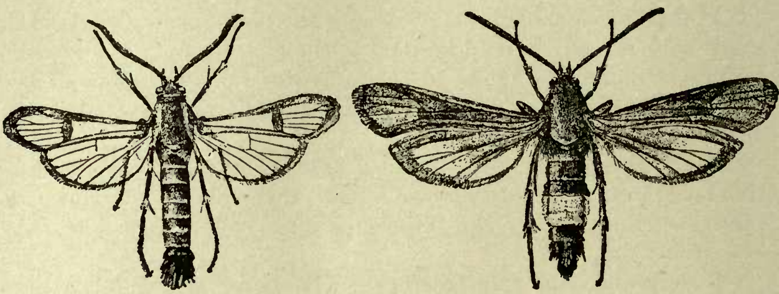
Peach-tree Borer (*Sanninoidea exitiosa* Say).—This destructive borer may completely girdle a tree. If the attack is severe—its presence indicated by the foliage turning yellow—the tree may eventually die.

Description and Life History.—The borer is the larva of a clear-winged moth. When full grown, it is about an inch long, and is light yellowish with brown head. The body is sparsely clothed with brownish hairs which arise from tubercles. The excrement thrown out of the burrow and observed on the bark indicates the presence of the pest. The caterpillar grows rapidly, hibernating during the cold weather, and resumes operations again in the spring. Its activities cause gum to exude from the tree. About two years are required for the life-cycle; the larvæ hatching in late fall do not become moths until the second season.

The moth itself, flying during the daytime, may be mistaken for a wasp. The female is deep, steel blue, with a broad, orange band across the abdomen. The fore-wings are opaque, covered with bluish scales, and expanding about one and one-fourth inches. The hind-wings are transparent, except the dark margin. The male is smaller than the female. Its wings are clear, except the margins and a line across the fore-wings. The abdomen is marked with three or four yellow stripes (Fig. 136). West of the Rocky Mountains, this form is replaced by *S. opalescens*.

Control.—Dirt may be heaped in a mound high on the trunk, forcing the moths to lay eggs at a distance from the ground, where the borers are more easily found when they begin their work. Many are kept out of the trees in this way. This mound can be leveled in the early fall, and the larvæ may be destroyed, by careful use of the wire and knife, at that time. The laying of eggs on the

trunk may be largely prevented by wrapping the trunk with building paper. This paper should extend an inch or two below the surface of the ground. These wrappings should be applied before the moths emerge and should be removed after egg-laying is over. One can also resort to digging the borers out in the fall and again in the spring. This is a good plan for the South.

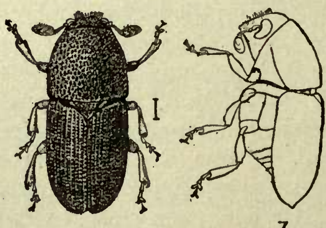


A *B*

Fig. 136.—Peach-tree borer (*S. exitiosa*): *A*, male; *B*, female.

The Plum-tree Borer (*Sesia pictipes* G. and R.).—This borer is quite a common pest, injuring the inner bark and sap wood of the trunk and limbs of plum and similar trees. It works somewhat after the manner of the preceding species. It is found in both the cultivated and wild plum and also in wild cherries. It turns into a clear-winged moth, the two sexes resembling closely the male of the peach-tree borer—in fact, is hardly to be distinguished from that species.

Control.—Cut out and burn infested parts of the tree.



a *b*

Fig. 137.—Fruit-tree bark beetle; dorsal view and in profile. (U. S. Bu. Ent.)

The Fruit-tree Bark Beetle (*Scolytus rugulosus* Ratz).—If it were not for various enemies this insect would be very injurious. The adult appears in early spring. Its presence is detected from the fact that the outer bark is penetrated by numerous small "worm-holes" or "shot-holes." From these holes the gum exudes, especially in the case of stone fruits. Weak or diseased trees are most subject to attack, but young, healthy trees may also suffer.

Life History.—From the worm-holes the beetles emerge in April and May (Fig. 137). The female burrows through the bark to the sap wood, where she eats out a vertical brood-chamber.

Along the sides of this chamber she gnaws out pockets, and in these places her eggs. The larvæ, upon hatching, excavate little side galleries, which are widened as the larvæ grow. Three weeks are required for them to reach full growth. The winter is spent in the adult form within the burrow.

The beetle is black in color; about one-tenth inch long and about one-third as wide. The very tips of the wing-covers and parts of the legs are reddish.

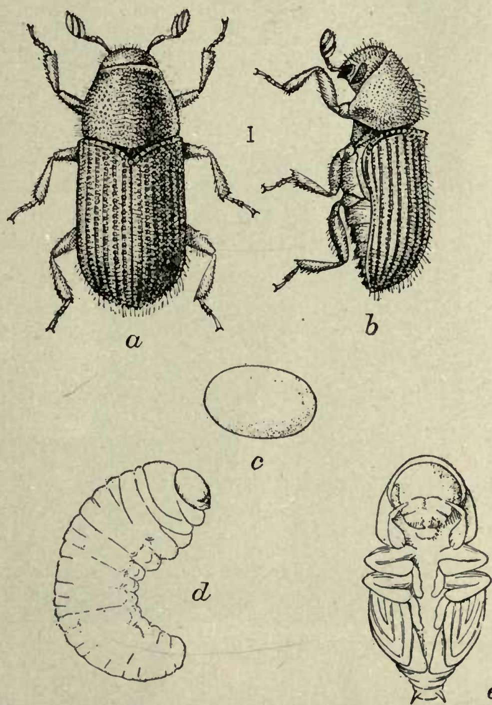


FIG. 138.—Peach-tree bark beetle: *a*, *b*, adult beetles; *c*, egg; *d*, larva; *e*, pupa. All greatly enlarged. (After Brooks, U. S. Bu. Ent.)

Control.—All infested parts should be cut out and destroyed. All prunings and trimmings from the trees should be burned. A whitewash applied to the trunks and larger branches in the spring and midsummer and again in late fall acts as a repellent. Or, better, apply a carbolic acid wash to the trunk and larger branches. Use one pint crude carbolic acid, one gallon of soft soap, then dilute

with five gallons of water. Orchards should be kept free from dead wood. A closely allied form, the peach-tree bark beetle, and its work are shown in figures 138 and 139.

The Pear-blight Beetle (*Xyleborus pyri* Peck).—This beetle may infest plum, pear, apple, and apricot. It is commonly regarded as infesting only weak and unhealthy trees, but, as in the case of the two bark beetles, sound trees are known to be infested also. It may attack not only twigs but also the trunk. The twigs, as a

FIG. 139.—Exit holes in peach limbs made by adults of peach-tree bark beetles, shown in figure 138. (Brooks, U. S. Bu. Ent.)

result of attack, die, but this must not be confounded with the death of twigs due to the disease known as pear-blight or fire-blight.

Life History.—The beetle deposits her eggs at the base of the buds. The young larva, upon hatching, works into the pith, causing the tree to wither. In the bottom of this burrow the larva changes to a pupa and later to the beetle. In June and July the adult emerges and lays its eggs before the end of August.

The adult is a small, cylindrical beetle, one-tenth of an inch long; deep brown or black.

Control.—Blighted trees or limbs should be cut off below the injured part and burned before the beetle emerges.

The Divaricated Buprestis (*Dicerca divaricata* Say).—The grub of this beetle, when full grown, resembles, in a general way, the flat-headed borer of the apple tree. It lives in the sap wood and destroys it by burrowing and feeding upon it. Pupation takes place just below the bark. The adults appear in June, July, and August, and at that time they may sometimes be seen in the bright sunshine on the trunks of the trees. The eggs are deposited in the crevices in bark of old plum and cherry trees; it also attacks the peach. The adult is a copper-colored beetle nearly an inch long, with brassy reflections. Its back is thickly pitted and also exhibits several depressed lines and small elevated spots. The posterior ends of the wing-covers are separated (Fig. 140).

Fig. 140.—Divaricated buprestis. (U. S. Bu. Ent.)

Control.—Control measures similar to those used for the flat-headed borer of the apple tree apply equally to this species. It is seldom very troublesome.

The American Plum-tree Borer (*Euzophora semifuneralis* Walker).—This moth appears in early spring and deposits eggs on the larger limbs of the plum trees. The young caterpillars eat their way into the tree, feeding upon the inner bark, and remaining under the bark until the following spring, when they emerge as adults.

Fig. 141.—Lecanium scale on plum.

Control.—When possible, destroy this borer with a sharp wire. A strong solution of soap and crude carbolic acid may be applied as a repellent. See also remedy for round-headed apple-tree borer.

The Plum Scale (*Eulecanium* sp.).—This is a large scale attacking the leaves and bark of the plum tree. The eggs are deposited in great numbers under the old scale in early summer. The young, when hatched, crawl about the tree, reaching the leaves and twigs,

where they become attached. In the fall they migrate to the under side of the branches (Fig. 141).

Control.—Commercial lime-sulfur may be used as a spray against this insect, applying it before the leaves appear. The spraying may be repeated in July, employing the summer strength. Directions for using this are found upon the can.

ATTACKING THE LEAVES OF PLUM

The Plum Gall-mite.—This is not an insect, but an allied form belonging to the branch of the animal kingdom known as *Arachnida.* Like other members of the group, it has, in the adult stage, eight legs instead of six. It is sometimes called the Pear-leaf Blister-mite. (See page 110). It is barely visible, but is destructive, in that by its work it causes the leaves to become distorted into the peculiar galls shown in the illustration (Fig. 142).

Fig. 142.—Work of plum gall-mite. (Original.)

Control.—The only method of control that can be suggested at this time is to pick off and burn the abnormal leaves, thus destroying the pests within. Commercial lime-sulfur is used as a dormant spray to destroy the winter forms.

The Plum-leaf Aphis (*Hyalopterus arundinis*).—The eggs of this aphis are laid on the plum twigs in the fall and hatch in the spring. Two or three generations are developed in the early summer on the plum, and then the insect migrates to other food plants, returning to the plum in the fall. This migration is accomplished by winged generations.

Injury.—This louse is extremely injurious in that it sucks the juices of the leaves and tender twigs, causing the leaves to drop prematurely, checking the growth of the tree and preventing the proper fruiting. If it occurs in large numbers, the tree appears blighted.

Control.—About a week before the buds open, spray the trees with one of the tobacco extracts, such as Black Leaf 40; or use whale oil soap, one pound to fifty gallons. Trees sprayed with lime-sulfur for the twig borer just before blossoming should not be troubled with aphids. This compound might also be used on

the foliage if aphids become numerous. In spraying against aphids or plant lice, the spray must reach the insects under the curled leaves and strike them with some force. Dipping the affected tips of the branches in a pan of nicotine sulfate solution and shaking the submerged twigs in the liquid is very efficacious and practical. For this use a tablespoonful to a gallon of water.

The Plum-tree Sphinx.—The adult moth of this species (*Sphinx drupiferarum* S. and A.) lays its pale yellowish green eggs singly, on the leaves of the plum. These eggs hatch in six to eight days. The full grown larva is rich green with lateral dark spots; oblique bands appear on each side of the body. It enters the ground a few inches to pupate, forming an earthen chamber. The pupa is dark, reddish brown and the pupal stage lasts from fall until the following spring. Figure 143 illustrates the moth.

FIG. 143.—Plum-tree sphinx. (Lugger.)

Control.—This insect seldom needs special attention. Four pounds of arsenate of lead in one hundred gallons of water is the usual remedy suggested. Hand-picking may be resorted to.

Mottled Plum-tree Dagger Moth.—The larva of this moth (*Acronycta superans* Guen.) is usually greenish, but may vary in color, showing a broad chestnut-colored stripe along the back. There are several tubercles bearing hairs on each segment, and other hairs are found along the side of the body. The caterpillar is one inch long, slightly compressed. The young caterpillars appear in June and again late in September.

The larva feeds on the foliage of plum, apple, mountain ash, birch, etc. It is also often found on shadberry and many other similar plants.

Control.—It is seldom abundant enough to become a serious pest, and is held fairly well in check by an ichneumon fly. If a spray is necessary, arsenate of lead would be very effective. The larva, after pupating, turns into a grayish moth.

The Plum-tree Catacola (*Catacola ultronia* Hubn.).—The larval form of this moth is a grayish brown caterpillar. It is about one and one-half inches long when full grown. The ninth segment bears a fleshy horn half an inch long, and an irregular grayish patch occurs on each side of the horn. There is a low, fleshy ridge on the twelfth segment (Fig. 144). The under side of the caterpillar is pinkish, and a row of black spots occurs on the mid-ventral line.

The adult moth has front wings of rich amber color, darker at the posterior margin. Several brown and white wavy lines cross

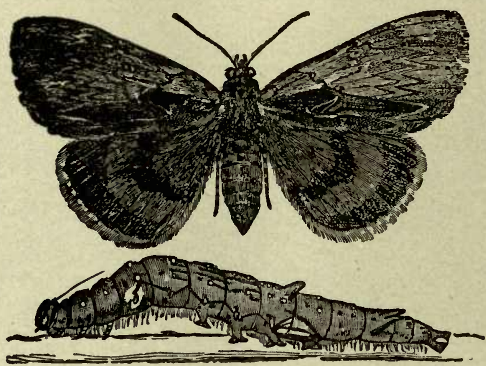


FIG. 144.—Plum-tree catacola.

the wings. The hind-wings are deep red, margined with a broad band of black. There is also a black band across the middle of the hind-wings.

Life History.—The winter is passed in the egg stage, the eggs being deposited in cracks in the bark. They hatch in the spring, becoming full grown about the end of June. The moths emerge and are on the wing during the most of July and August, at which time eggs are deposited for the next brood. Injury by this insect is not often serious.

Control.—Arsenical sprays would be effective if necessary. Jarring for plum curculio frequently causes caterpillars of this species to drop off.

The Rusty-brown Plum Louse (*Aphis setariæ* Thomas).—This rusty-brown aphid has the base of the antennæ white, which color also appears on the legs and on the posterior end of the insect. It is first observed in early spring on tender shoots of the plum, secreting honey dew in abundance. Its secretion frequently causes the upper surface of the leaves below the lice to present a shiny, glistening effect.

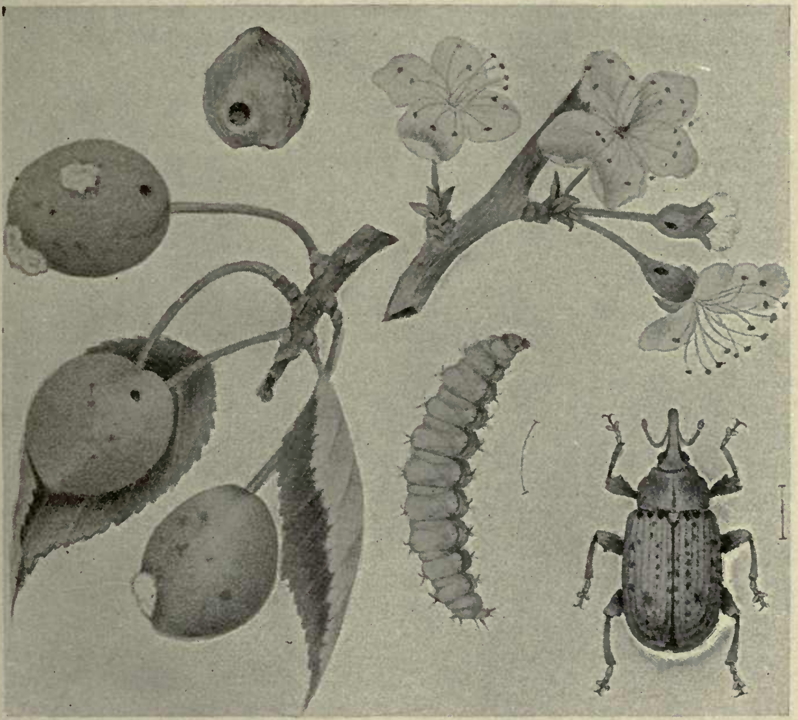


Fig. 145.—Plum gouger, adult, larva, and injured fruit. (Lugger.)

These lice remain on the plum during the entire year, but grasses may be also attacked during the summer. As summer advances, many of these insects may become a deep black; in fact, the egg-laying females and the true males are strikingly black. The oviparous female is wingless, while the male is winged. Winged forms are produced at different times during the summer or fall.

Control.—As in treatment for all plant lice, tobacco extracts are recommended as sprays or as dips. Also use soap solution. (See under plum louse.)

ATTACKING THE FRUIT

The Plum Gouger (*Coccotorus scutellaris* Lec.).—This snout-beetle resembles somewhat the plum curculio, but lacks the humps on the back. The insect is one-fourth of an inch long, with a snout

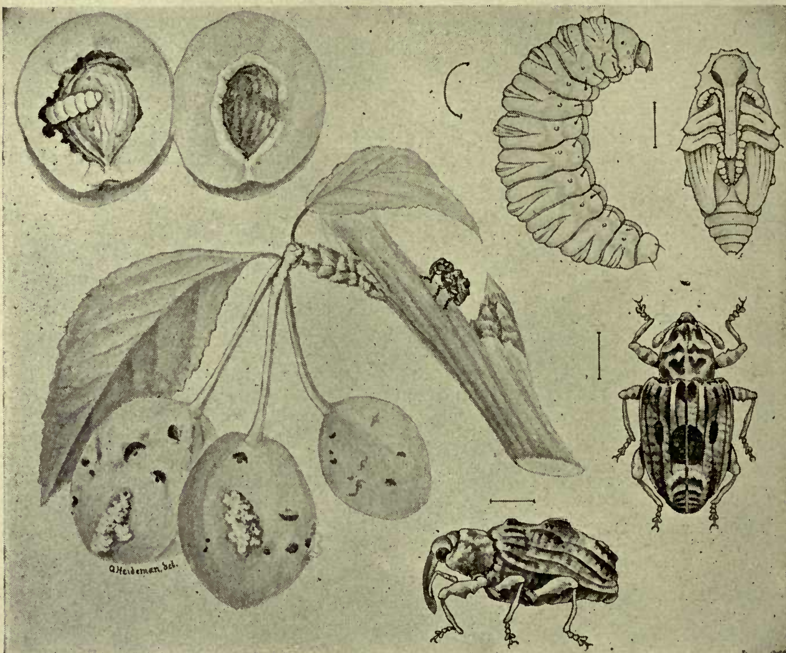


FIG. 146.—Plum curculio, adults, larva, pupa, and infested fruit. (Lugger.) Hair lines indicate natural size in each case.

about half the length of the body. The wing-covers are lead gray, finely spotted with black and brown. Yellowish markings are on the thorax and head (Fig. 145). They feign death when disturbed.

Injury.—The beetles puncture the calyx and feed on the ovary of the flower, destroying it. Later, for purpose of obtaining food and for egg-laying, they puncture the growing plum. These small holes made by the proboscis exude gum. The affected plums do

not drop off as is the case with those injured by the plum curculio, but badly punctured fruit becomes gnarly and worthless. After the egg is placed in the puncture made by the female beetle, it is pushed down with the insect's snout.

Life History.—The egg hatches in a few days, the grub working toward the kernel of the pit. It is single-brooded, its complete development requiring about three months. It hibernates in the adult stages, appearing on the tree at blossoming time.

Control.—If this pest is unusually abundant, use a spray of two to three pounds of arsenate of lead in a barrel of water, just as the blossoms fall, and again three weeks later.

The Plum Curculio.—Full treatment is given under apple insects, as in some localities it is a destructive pest of the apple. Figure 146 is an excellent representation of this insect in its various stages and of the injury it causes upon stone fruits.

Supplementary List for Plum.—Many other insects besides those just described are less commonly found attacking the plum. In the following list the pages given are for the descriptions given in this book.

Apple-leaf hopper, p. 83
Banded hair-streak
Blind-eyed sphinx
Bud-moth, p. 98
Buffalo tree-hopper, p. 78
Brown fruit chafer, p. 105
Cecropia silk moth, p. 91
Cherry-leaf beetle, p. 132
Cherry-tree scale, p. 127
Cherry-tree thecla
Dominican case-bearer
Double-eyed sphinx
Fall canker worm, p. 89
Fall web worm, p. 265
Flat-headed apple-tree borer, p. 188
Grape flea beetle, p. 155
Gray dagger-moth
Hop plant-louse, p. 214
Io emperor moth, p. 128
"June bug," p. 211
Leaf crumpler, p. 98
Long-horned prominent
Oblique-banded leaf roller, p. 96
Oyster-shell bark-louse, p. 72
Putnam scale, p. 74
Rose chafer, p. 156
San José scale, p. 70
Scurfy scale, p. 73
Tarnished plant bug, p. 84
Tent caterpillar, p. 78
Thysbe clear wing
Tree cricket, p. 140
Unicorn prominent
Viceroy
White-marked tussock moth, p. 269

ATTACKING TRUNK, BRANCHES, AND TWIGS OF PEACH

For a discussion of the Eastern peach-tree borer which injures peach trees see page 113. And for a treatment of the fruit-tree bark beetle, see page 5.

Pacific Peach-tree Borer (*Sanninoidea opalescens* Edw.).—This species is found on the Pacific coast, where it exhibits the same habits as its eastern congener, and resembles it closely. The steel-

blue abdomen of the female, however, lacks the yellow band seen in the eastern form.

The same measures of control as employed against the eastern form are adaptable in the case of this west coast species. See treatment for peach-tree borer.

The Peach Twig-borer.—This small gray moth (*Anarsia lineatella* Zell), barely one-half an inch from tip to tip of extended wings, is an importation from Europe and a serious peach pest in many of our states, particularly on the Pacific coast.

The brownish larva is about one-half an inch long when adult. During its active life it bores in the pith of tender growth, causing the tips of branches to wither and die (Fig. 147). The insect at this stage is very active and voracious, and crawls from twig to twig, causing extensive injury. It pupates under scales of bark on large branches. The female moth lays her white eggs on the young twigs. About ten days are required for hatching.

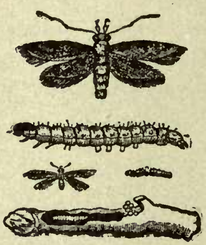


Fig. 147.—The peach twig-borer.

Fruit may be attacked by the second brood of caterpillars, and the third brood feed entirely on the fruit. A fourth brood of caterpillar gives rise to the moths whose eggs, placed in cracks in the bark, produce the caterpillars which winter over in bark close to the young growth.

Control Measures.—The best measure of combating this pest is by the use of frequent winter sprayings of lime-sulfur. Use one part commercial lime-sulfur to ten of water. In the spring, from the time of the swelling of the buds until the blossoms begin to appear, a little later, just as the blossoms show pink, arsenate of lead may be applied at the rate of five or six pounds in fifty gallons of water.

Terrapin Scale or Peach Lecanium.—This is a turtle-shaped or terrapin-shaped scale (*Lecanium nigrofasciatum* Perg.) about one-eighth of an inch long when full grown. It is brownish or reddish in color; individuals may be found which are nearly black. The young hatch beneath the mother scale and attach themselves to the leaves later. After the females have been fertilized by winged males, they migrate to the twigs and branches.

Control Measures.—Spray with miscible oils when the trees are dormant. Care has to be observed in using this spray on the peach. It should not be used in the fall, but is best applied in early spring.

Miscible oils are commercial sprays known as "Scalecide" and "Kil-O-Scale." Other dormant sprays for scale insects would probably be equally effective.

Tree Crickets sometimes inflict serious injury, directly and indirectly, upon peach trees, cherry trees, and many others. Figure 148 illustrates some of these. (See also page 140.)

ATTACKING THE LEAVES AND FRUIT OF PEACH

The Black Peach Aphis.—This is blackish or brownish larva of *Aphis persicæ-niger* Smith. It is found on leaves, and in the winter and summer wingless forms occur on the roots. Some of these later migrate to leaves when they appear. Their life history is, in a general way, similar to that of other aphids or plant lice, and, like other forms, they multiply with amazing rapidity. The yellowing of peach leaves is frequently due to the presence of the underground form, which, though unseen, is sucking the vitality from the tree.

Measures of Control.—Frequent spraying with tobacco extract is effective against the leaf form if applied with force to the under side of the leaves. Use two tablespoonfuls of nicotine sulfate in one gallon of water with a little soap. For the root form remove some of the earth from about the roots and apply a liberal quantity of tobacco dust or tobacco stems, covering the same with earth.

Trees received from an infested nursery may bring this pest into an orchard which would otherwise be free. If lice are observed upon the roots of such trees when purchased, dip the roots in a strong tobacco solution.

The Tarnished Plant Bug or "Peach Sting."—This insect, discussed on page 84, frequently attacks young trees twenty to twenty-four inches high, causing the terminal bud to wilt. This may occur on both leader and lateral. Since a portion of the life of this insect is passed on various weeds and cultivated plants, clean cultivation in and about an orchard is recommended.

The Green June Beetle.—These greenish beetles (*Allorhina nitida* Linn.) have yellowish markings on the side. They frequently feed upon the fruit of the peach. The clumsy, whitish grubs from which they develop in two years are found in the ground, particularly where it has been abundantly treated with manure or other dressing (Fig. 149).

Repeated hand-picking and destruction of the beetles appears

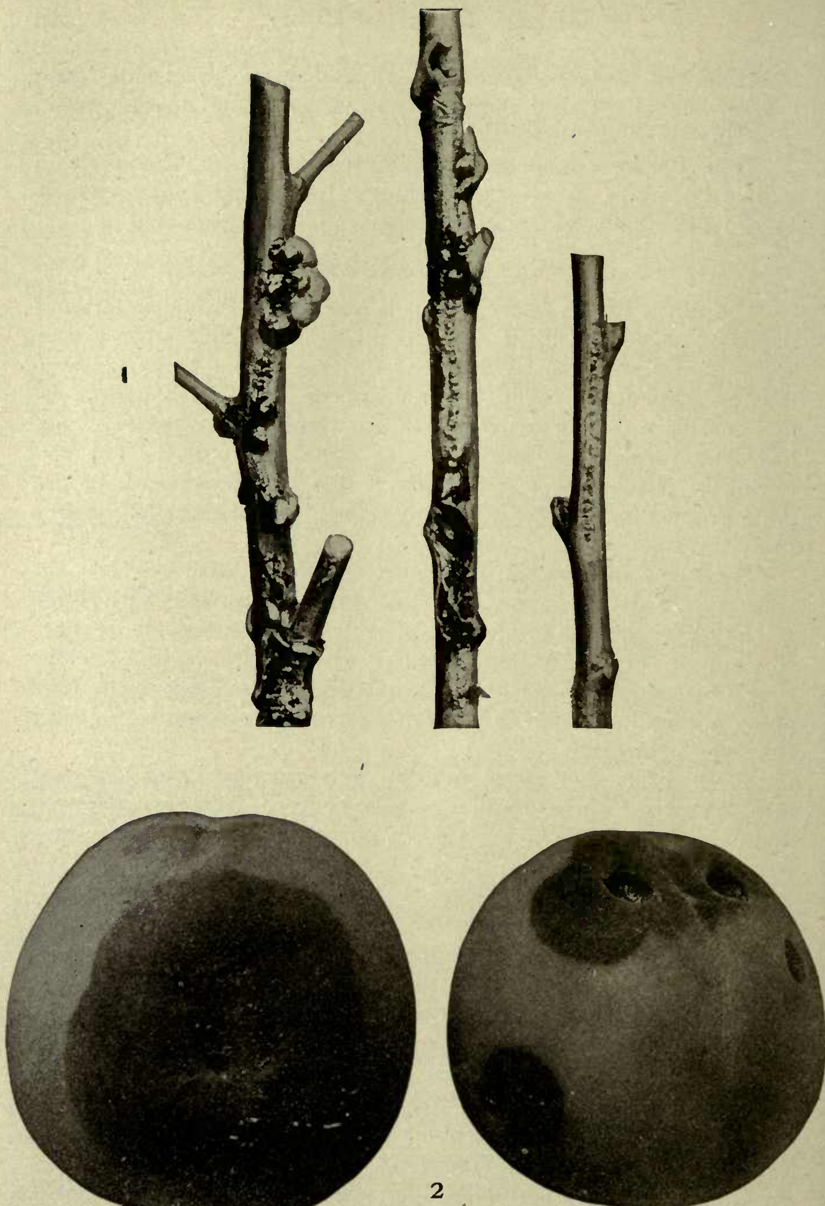


FIG. 148.—Peaches suffer at times from attacks of tree crickets; 1, scars in peach wood caused by egg-laying; 2, brown rot infection of peaches following feeding. Photo by Garman. (Parrott and Fulton, Geneva Bull., 388.)

to be the only practical remedy. This beetle also attacks the fig, in which connection it is known as "The Fig Eater."

Supplementary list of peach insects.—

Codling moth	Plum curculio
Peach saw fly	Tent caterpillars
Pear thrips	White peach scale

ATTACKING TRUNKS AND BRANCHES OF THE CHERRY

The Flat-headed Cherry-tree Borer or **Divaricated Buprestis** is discussed on page 117; it attacks several of the stone-fruit trees.

The Cherry-tree Scale or Bark-louse.—This black scale (*Eulecanium cerasifex* Fitch) is found on the lower side of limbs

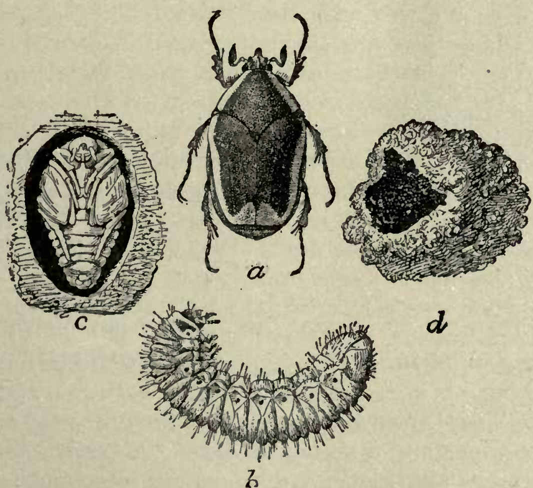


FIG. 149.—The southern June-beetle, or fig eater: *a*, adult; *b*, grub; *c*, pupa in cell; *d*, empty cell.

of the cherry tree. Egg masses are produced under the scale, and the young, upon hatching, in the early summer, spread over the tree, attaching themselves finally to the under side of tender branches, where they soon cover themselves with a scaly secretion. The adult stage is reached before the beginning of winter.

Control.—The usual summer and winter treatment for scale applies in the case of this insect.

The European Fruit Eulecanium.—This scale is somewhat similar to the preceding insect, and is a related species, *E. corni* Bouche. It injures the tree by sucking the sap therefrom and thus interferes with the growth. The adult scale is one-eighth of an

inch long, nearly hemispherical; yellowish when young, becoming dark and shiny when older. The hard part of this and allied scales is really a part of the insect and not separable from the insect, as is the case with the oyster-shell scale, San José scale and some others.

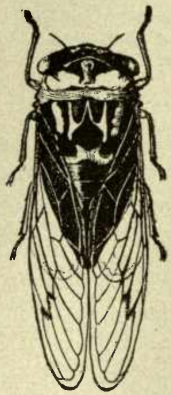


FIG. 150.—Dog day cicada. (Lugger.)

Control.—The life history and control is practically the same as in the preceding species.

The Dog Day Cicada.—This is a well-known insect in many latitudes (*Cicada tibicen* Linn.). It is seen and heard during August and September and is commonly called "locust." The upper side of the body is black, the head and thorax being mottled with olive green. The large, transparent wings are strongly veined; the more prominent veins have a greenish tinge. The under side of the body is coated with a whitish powder. The legs are greenish (Fig. 150). Not much is known regarding the larvæ. Probably both the larval and pupal stages resemble those of the periodical cicada or so-called "seventeen-year locust."

Like other species, the adult often wounds the small limbs of the cherry and deposits eggs in the wounds.

INSECTS ATTACKING THE LEAVES OF CHERRY

Io Emperor Moth.—The male of this striking moth (*Hyperchiria io* Linn.) is of a deep yellow color, with faint purple-brown markings. There are two oblique, wavy lines near the outer margin of the fore-wings and a zigzag line near the base. There are also other markings and blackish dots on the fore-wings. The hind-wings are of a deeper yellow color, shaded with purple next to the body and with a large blue eye-spot in the center. The wing expanse is about two and one-half inches.

In the female, the hind-wings are somewhat like those of the male. The fore-wings are somewhat duller in color, and the wing expanse is from three to three and one-half inches.

The larvæ.—The dark-colored larvæ keep together while young in small swarms, and when moving march in a procession, as it were. Later they lose this habit and spread, maturing late in the summer. When full grown, they are two and one-half inches long, approximately, pale green, the green becoming paler along the back, and there is a broad, dusky-white stripe on each side margined with lilac. The body of the larva is covered with

bunches of branching spines, tipped with black. These spines are capable of inflicting a painful wound on tender skin.

The caterpillars feed not only upon cherry but also upon apple, willow, elm, poplar, oak, currant, clover, etc.

Control.—If troublesome, the species may be easily controlled by hand-picking. Gloves should be worn for this work. As stated elsewhere, a spray of arsenate of lead controls all leaf-eating forms of insects without injury to the most tender tree.

The Pear and Cherry Slug.—This insect in its immature form is a small, dark green, slimy slug (*Eriocampoides limacina* Ratz). It later turns into a black, four-winged insect known as a saw-fly (Fig. 151).

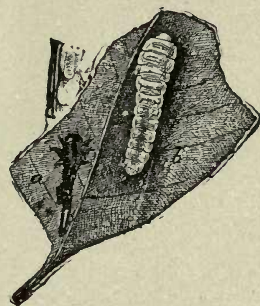


Fig. 151.—Cherry slug on leaf.

Life History.—The female lays eggs in the tissues of the leaves, at intervals during the summer, giving rise to several broods of slugs. This slug, when first hatched, is whitish. There are apparently four moults. After the last moult it loses its slimy appearance and becomes yellowish in color, crawling or falling to the ground and forming a pupal chamber three or four inches below the surface, emerging as an adult, four-winged saw-fly in two or three weeks.

Injury.—This slug feeds on the upper side of the leaves of cherry, plum, etc., causing the foliage to wither and appear scorched as by fire.

Control.—Spraying with a weak solution of arsenate of lead will prove effective. Use one pound to fifty gallons of water. Or use white hellebore, one ounce to three gallons of water. Air-slaked lime or even road dust thrown on this insect is fatal. Trees protected from other insects by arsenical sprays would not be injured by this pest.

The Cherry Louse (*Myzus cerasi* Fabr.).—These are black, shiny plant lice, working upon the young shoots and tender foliage of cherry trees.

Description and Life History.—Like other plant lice, they multiply with great rapidity, giving birth to living young during the summer. Also, like other members of this group, they secrete a sticky honey dew which attracts ants, wasps, and two-winged flies. Winged generations appear during the summer. The last generation in the fall usually produces winter eggs. These, in turn, hatch into "stem-mothers," which, in the following

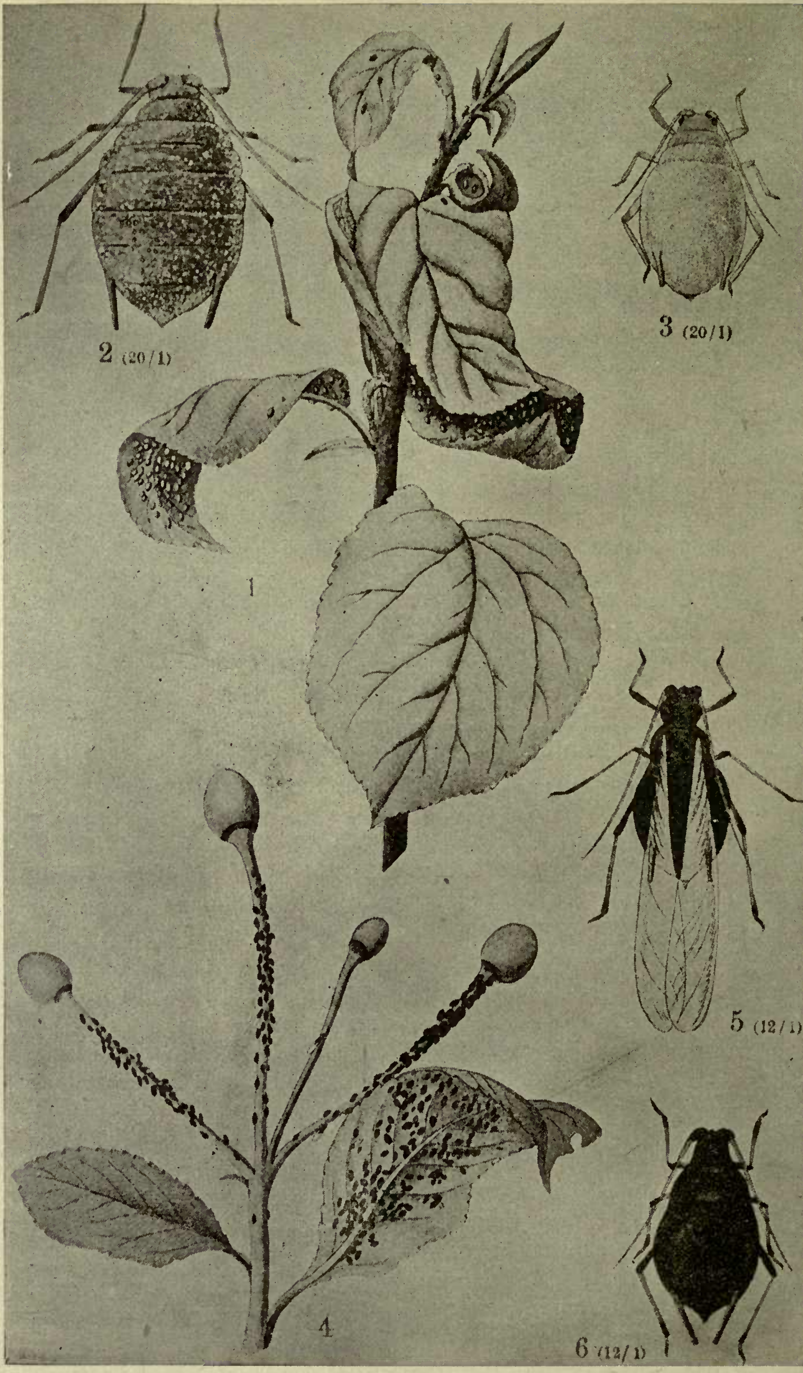


FIG. 152.—*A. sorbi*, 1, 2, 3, infesting apple. *Myzus cerasi*, 4, 5, 6, infesting cherry. (After Kirchner and Boltshauser.)

spring, start new generations. See figure 152, which also illustrates *A. sorbi*, occurring on apple trees.

Control.—These insects may be controlled with any of the tobacco extracts. Special care must be taken to strike all the

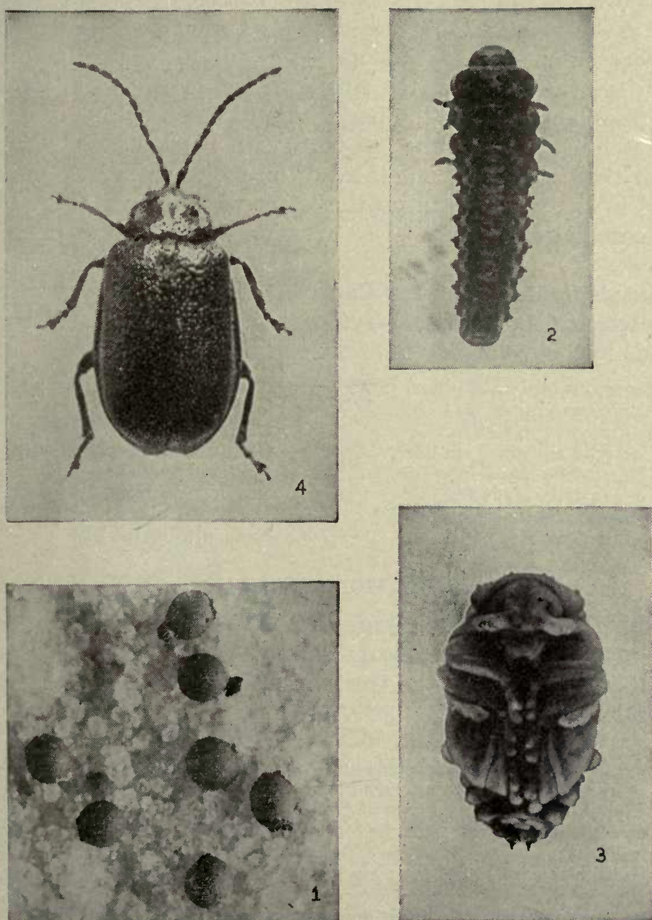


FIG. 153.—Cherry-leaf beetle: 1, eggs; 2, larva; 3, pupa; 4, adult. (From Geneva Bull.)

lice, which are concealed under the leaves, with the spray solution. A better way, where trees are in the nursery or not too large, is to bend over the affected branches and swash the infested tips in a pan of tobacco extract. Black Leaf 40, for example, may be used

at the rate of two tablespoonfuls in a gallon of water. This is the best way to handle all plant lice on the ends of branches upon trees not too high for such treatment.

Cherry-leaf Beetle.—Ordinarily, attacks on the part of this insect (*Galerucella cavicolis* Lec.) are confined to wild cherry, but early in the summer these beetles freely attack cherries in orchards.

Description and Life History.—The adults are small red beetles which lay their eggs in the spring in soil close to the trees, but they may be placed on the bark. About three weeks are required for hatching. The grubs are born with black head. When full grown they are about one-third of an inch long. The pupæ are found in the ground during the latter part of July (Fig. 153).

Remedial Measures.—Use arsenate of lead spray or nicotine sulfate.

Supplementary List for Cherry.—The following are other insects which attack the cherry. See page references to those described in this volume.

American tent caterpillar, p. 78
Apple-twig borer, p. 157
Canker worm, p. 87
Cecropia silkworm, p. 91
Cherry-tree leaf-folder
Cherry-tree Thecla
Eye-spotted bud-moth, p. 86
Fall web worm, p. 265
Forest tent-caterpillar, p. 80
Gray dagger-moth
Leaf crumpler, p. 98
Oak pruner, p. 281
Purblind sphinx
San José scale, p. 70
Tarnished plant-bug, p. 84
Tree crickets, p. 140

FIG INSECTS

The Fig Eater or June Bug.—For a description of this insect, see page 127. Fig trees attacked should be jarred, causing the beetles to fall on sheets below the tree, where they can easily be gathered up and destroyed.

QUESTIONS

1. Give life history of peach-tree borer. Describe injury caused by same and enumerate protective measures and other methods of control.
2. Enumerate the injuries caused by the peach-twig borer.
3. Give life history of plum-leaf aphis. What measures would you take against it?
4. Describe the work and give life history of the plum curculio and methods of control.
5. Do the same with the plum gouger.
6. Give life history of the black peach aphis and control measures.
7. Give life history of the flat-headed cherry-tree borer and remedial measures.
8. Give life history of the Dog Day cicada and describe its work.
9. Describe and give control measures for the pear slug.
10. Describe the Io emperor moth.
11. What are methods of controlling the cherry louse?
12. Describe and discuss the cherry-leaf beetle. Give methods of control.

CHAPTER X

INSECT PESTS OF BERRIES AND GRAPES

Berry growers are found over a large portion of the United States, and in many sections berry-growing is the chief means of livelihood. Grapes, which are really berries, botanically, are grown commercially in favored localities. The insect pests affecting these plants are given in this chapter.

INSECTS INJURING STRAWBERRIES

Attacking the Roots of Strawberry Plants.

The Strawberry Crown-borer.—The adult beetle (*Tyloderma fragariæ* Riley) is wingless, about one-sixth of an inch long. It is brown, marked with several dark brown spots, as well as with lines and dots running lengthwise of the body (Fig. 154). When full grown the grub is white, with a horny, yellow head.

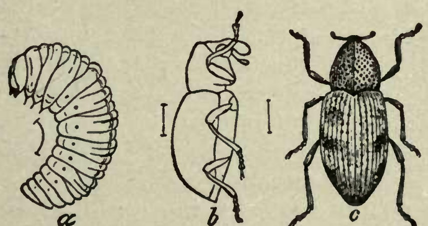


Fig. 154.—The strawberry crown-borer. (After Riley.)

Life History.—It is first observed in June or July, at which time it deposits an egg on the crown of the plant. The grub, after hatching, burrows down into the crown, feeding upon the tissues. The pupal or resting stage is passed within the crown or root, the adult emerging some time in late summer.

Control.—Infested plants are almost sure to succumb. These should be dug and burned after the fruiting season and before the grub has time to complete its transformation and emerge as an adult. If strawberries are cropped only one year and if a bed is placed at a distance from the bed of the preceding year, the danger of serious injury from this insect is but slight.

The Strawberry Crown-miner.—The species here referred to is regarded by some as identical with *Anarsia lineatella* Zell, which was described under insects affecting peach. In the strawberry, the caterpillar becomes fully grown in early summer, changing to a small, reddish-brown chrysalis in one of the cavities excavated in the crown or in the dead leaves. The moth, upon emerging, lays eggs in the crowns of several plants, depositing usually but one egg in each. This is done during middle and late summer. These eggs soon hatch and the caterpillar bores into the heart of the plant, remaining in its excavated chamber during the winter, enclosed in a silken cell. Affected plants wither and die. Even if they survive the attack, the plants are weak and worthless.

Control.—No practical remedy is known. Badly infested plants should be dug up, burned, and new ones planted. New beds should be set each year in new locations.

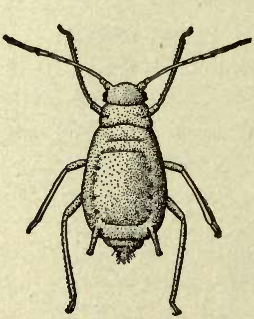


Fig. 155. — The strawberry root-louse. (Original.)

The Strawberry Root-louse (*Aphis forbesi* Weed).—This species passes the winter in the egg stage. The eggs are black and clustered on the stems and leaves. They hatch in early spring. The young aphids attack the leaves and later the crowns of the plants. They become adult in about twelve days and then produce living young (Fig. 155). The second generation is wingless. This generation is generally taken to the roots by the corn-field ants, which are attracted on account of the sweet juice secreted by the lice.

Many of the third brood are winged and are carried to other plants by the wind. Winged forms may also appear at any time when food is lacking. These winged forms start new colonies. The fourth generation appears in early summer and contains some winged forms. The sexual forms appear in the fall, the females then laying eggs, in which stage the winter is passed.

Injury.—Frequently, as a result of the work of this insect, one sees portions of a strawberry bed wither, causing bare spots in the patch, and ants may be observed about infested plants.

Control.—Avoid buying infested plants or using infested plants for starting new beds. If plants with infested roots must be planted, dip the roots in tobacco decoction before planting. If a new bed must be planted near an old infested bed, plow the old

bed under the previous fall. If the aphids appear early in the spring, spray the strawberry crown with nicotine solution—one part to 1000 parts of water. Affected plants intended for shipment should be fumigated for ten minutes with hydrocyanic acid gas, made by using: Potassium cyanide, 1 ounce; sulfuric acid, 2 ounces; water, 4 ounces. This is for every one hundred cubic feet of space. (See page 62.) The deadly nature of this gas should not be overlooked, and precautions must be taken to insure safety. (See also methods of control given under strawberry crown-borer and strawberry crown miner.)

White Grubs.—The larval forms of different species of Lachnosterna are called June beetles, May beetles, or June "bugs." The larvæ are commonly called grub worms. They are undoubtedly the worst of the pests attacking strawberries. They feed also on potatoes, roots of young evergreens in nurseries, and roots of young apple stock. A strawberry crop following directly after sod is very apt to suffer, since the grubs, deprived of their natural food, turn their attention to cultivated plants.

Life History.—Ordinarily, eggs are laid by the beetles in grass or sod lands some time in May or June. Grubs hatch in July and begin feeding on rootlets. They grow to less than one-half inch during the first season, retiring, so it is claimed, below the frost line when winter sets in. This statement is questionable where northern latitudes are concerned. The second season they continue feeding and grow to about one inch in length. Growth is completed the third season in midsummer, and the pupal stage is passed in a cell a few inches below the surface of the ground, the pupa gradually changing to an adult, and remaining below the ground until the following May, when it emerges.

Control.—Where these white grubs are actually in a strawberry field, there is nothing to do but dig them out when a plant shows injury. If it is necessary to use sod land for strawberries, such land should be plowed in early September. This process tends to kill a portion of the brood ready to transform, but will not kill the younger grubs while in the ground. A rotation of crops is desirable, and the sod should be followed with some crop other than strawberries for two years or more. Clover is said to be ideal for this purpose, as these insects do not attack it severely. Cropping strawberries for one year only is manifestly another way of avoiding injury. Where hogs can be used in infected land, they are a great help. Since the most severe injury from white grubs is periodic,

experiment station workers in the various states can generally advise their constituents of the probable occurrence in numbers of this pest and make suggestions regarding strawberry planting.

Attacking the Leaves of Strawberry Plants.

The Strawberry Leaf-roller.—This moth (*Ancylis comptana* Froehl.) appears in the strawberry fields during May, and, shortly after, eggs are laid on the under side of leaves. The small brownish or greenish larvæ hatch in five to seven days and at once begin feeding on the upper surface of the leaves (Fig. 156). At first they are about one-eighth of an inch long and feed unprotected; but they soon begin to draw the sides of the leaves together until they are concealed in a complete fold. Feeding continues within the shelter, and pupation occurs about four weeks later, within the leaf. The moth emerges nine or ten days later. There are three broods each season.

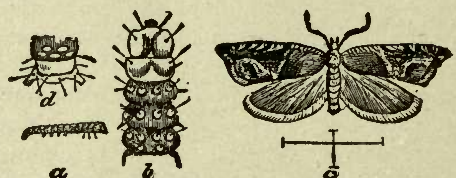


Fig. 156.—The strawberry leaf-roller: *a*, larva, natural size; *b*, anterior segments of larva, enlarged; *c*, adult, hair lines indicating length of insect and spread of wings.

Control.—Old leaves should be burned on the patch in the late fall. When a strawberry patch is no longer useful, it should be completely plowed under in autumn or early spring. The patches, when bearing, call for a properly timed spraying with four pounds of arsenate of lead to one hundred gallons of water. This spraying should be made about a week after the moths are first noticed. By that time the eggs first laid will be hatching, but no leaves will yet be folded.

The spraying should completely cover the upper surfaces of the leaves, but should never be used after the berries begin to color. One is further advised to avoid the use of plants from infested districts.

The Obsolete-banded Leaf-roller.—The adult of this insect (*Archips obsoletana* Walk.) is a small, brown moth appearing in spring, and depositing eggs which overlap in clusters. The larvæ, hatching in about ten days, are light yellow in color, with brownish heads.

Injury.—They feed on the under side of leaves, skeletonizing small areas. They roll the leaves and fasten them with fine webs.

Broods.—When full grown, these caterpillars spin thin cocoons and remain in the pupal stage about ten days. The first brood of larvæ appears in the spring, and a second brood early in the fall. Their method of hibernation is somewhat in doubt.

Control.—A patch known to be infested should be sprayed with arsenate of lead just before the blossoms open in the spring. Spray thoroughly after the fruit has been picked. Or the strawberry tops should be mowed soon after the fruit is picked, and when dry burn them on the field. See also method of control given under the strawberry-leaf roller.

The Strawberry Slug.—The adult is a four-winged fly (*Empria maculata* Norton) about one-fourth of an inch long, with a row of small white spots along each side of the abdomen. The larvæ resemble small green worms. They feed upon the leaves for five or six weeks and then enter the ground to pass the winter in the pupal stage.

Control.—If there is fruit on the plants, spray with white hellebore; use two ounces to three gallons of water. Dusting with Paris green and air-slaked lime is effective and may be used when there is no fruit present. After the last picking the tops should be mowed and the field burned over.

Attacking the Fruit.

The Strawberry Weevil.—This is a small, black or brown snout beetle (*Anthonomus signatus* Say) about one-tenth of an inch long.

Life History.—After depositing its eggs in fruit buds, it gnaws the stem just below the bud, causing it to wilt. The young grubs feed on the wilted bud for a few weeks and then change to pupæ. The adults later emerge from the dried buds and go to other flowers for feeding purposes. They disappear about the middle of summer, at which time they probably go into permanent quarters for the following winter. There is only one brood.

Since young and old feed upon pollen, pistillate varieties of strawberries—that is, strawberries lacking stamens—are exempt from attack. Late in the season the adult beetles feed upon the leaves.

Control.—Clean culture is very essential in controlling this insect, since it passes the winter under rubbish in the field. Old

fields should be plowed as soon as the berries are picked. The leaves might be sprayed after the crop is gathered. Use arsenate of lead at the rate of three pounds in fifty gallons of water. Plant pistillate varieties as far as possible.

Ground beetles at times cause injury by gnawing into the fruit of the strawberry. These insects (*Harpalus pennsylvanicus* DeG. and *H. caliginosus* Fabr.) are, for the most part, carnivorous, attacking injurious caterpillars, and hence are beneficial. They probably attack the strawberry for its seeds, but their fondness for seed has extended to the pulp also. Their work is done mostly at night, the beetles hiding under stones or clods of earth or mulch during the day. The larvæ or grubs live in the ground.

Control.—Experiments in the control of these insects have never been fully worked out. The beetles are attracted to strong lights at night and may be trapped by lanterns or may be caught in traps with meat baits. Short pieces of boards also may be placed at intervals over the patch and offer favorable hiding places. The insects gather under these boards and can be collected and killed during the day. English growers trap an allied form by the use of dishes with high smooth sides sunk in the ground and baited with meat.

The tarnished plant bug is discussed on page 84, under the head of Apple Insects.

Supplementary List for Strawberries.—Several other insects also attack the strawberry. Page references are given for those described in this book.

False chinch-bug
Glassy cut-worm
Greasy cut-worm
Imbricated snout beetle
Oblique-banded leaf-roller, p. 96
Rusty-brown tortrix
Stalk borer, p. 256
Sulfur brown tortrix
Thread-bearing span worm
Wavy-striped flea beetle
Wire worm, p. 206

INSECTS ATTACKING RASPBERRY AND BLACKBERRY

Attacking the Roots or Canes.

The Blackberry Crown-borer or **Raspberry Root-borer.**—This is a clear-winged moth (*Bembecina marginata* Harris), shown in figure 157.

Life History and Habits.—The adult moth deposits its eggs in midsummer on the leaves. These eggs are deep brownish red in color. Each female lays about one hundred and forty. The young,

white, grub-like larvæ crawl down the stems and bore under the bark, eating into the pith. They feed downward in the pith during the fall, passing the winter in the roots. The next spring finds them working upward in other canes. When full grown they eat nearly through the stem walls a few inches above the ground level and there change to the pupal stage. At this time they are pale yellow with brown heads.

Before the adult emerges, the chrysalis pushes itself part way through the unbroken skin of the cane, and when the adult escapes the chrysalis's skin remains in the opening.

Injury.—These injurious insects may entirely girdle a stem at the ground. They are particularly destructive in that, in the spring, they abandon the old wood and attack the new. Plants attacked generally make a poor growth and may die if the roots have been badly affected. Infestation may come from wild canes in the vicinity.

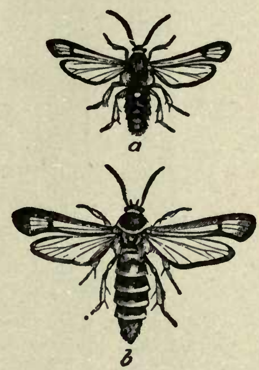


FIG. 157.—The raspberry root-borer; blackberry crown-borer. *a*, male; *b*, female.

Control. — Infested canes should be pulled up or cut off below the work of the borer and destroyed by burning. Or the borer should be cut out as soon as its work is observed. The various pests attacking canes may all be controlled, to a large extent, by a judicious pruning and cutting out every spring. In the middle and southern states, blackberry canes may be entirely mowed down after the crop is harvested. The canes are to be burned immediately. Young shoots will be sent up and become mature before fall.

The Raspberry Cane-borer (*Oberea bimaculata* Oliv.).—The tips of young shoots of raspberries and blackberries sometimes wither and die, due to the attack of this pest, which tunnels through the center of the canes.

The adult is a slender, dark beetle with a yellow ring back of the head, and with long antennæ or feelers. The larva, when full grown, is one inch long, dull yellow, with a small brown head. Two years are required to complete the life cycle.

Control.—Withered tips should be cut off below the point of girdling and burned as soon as cut. This pruning should be done before the larvæ go into the crown off the plant to hibernate.

The Red-necked Cane-borer.—Both blackberries and rasp-

berries are attacked by this elongated, flattened, bronze-colored beetle (*Agrilus ruficollis* Fab.). It is about one-third of an inch long. The eggs are deposited near the ground in the axil of the leaf stalk. The young grub eats into the cane at this point and causes the formation of the raspberry gouty gall (Fig. 158). As the gall enlarges, the surface becomes rough and cracks. The larvæ tunnel along in the sap wood in an irregular course. When mature, the insect is pale yellow or whitish, with a very small brownish head and black jaws. It is about five-eighths of an inch long. Several larvæ may be found in a single cane. They pupate in the pith; and emerge as adult beetles in early summer.

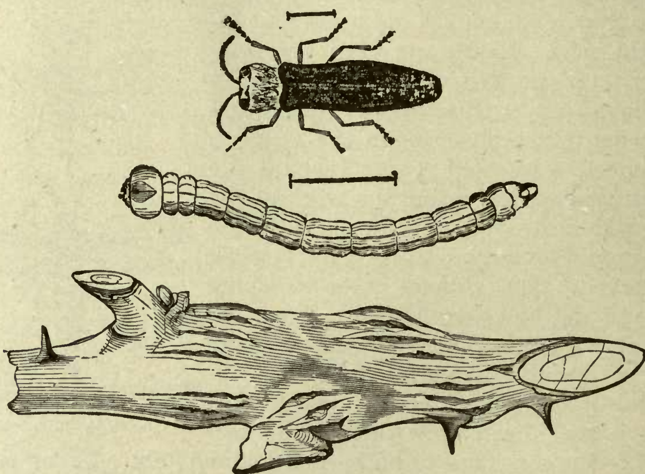


FIG. 158.—Red-necked cane-borer, adult, larva or grub, and gall. (After Riley.)

Control.—Galls thus formed should be cut out and burned during the winter, late fall, or early spring, while the larvæ are hibernating. All wild canes in the neighborhood should be destroyed and clean cultivation practiced as far as possible. Infested canes in the berry patch should be cut out and destroyed before summer.

The Snowy Tree-cricket.—This tree-cricket (*Œcanthus niveus* DeG.) is of a delicate greenish white color, lighter than the allied form *O. fasciatus*, from which it is also distinguished by marks on the basal joint of the antennæ (Fig. 159). It is quite musical and may even be heard occasionally within houses, where it accidentally occurs.

Life History.—The eggs are laid in the late fall, gashes being cut in the stems by the female for this purpose (Fig. 160). The canes are thus weakened, breaking down under the weight of snow or by the influence of the wind. The eggs hatch in late spring. Figure 161 illustrates interesting features in connection with the life history of tree crickets. Figure 162 gives a clear idea of the different stages in the hatching.

Habits.—These insects, while harmful, should be credited with doing a large amount of good, in that they feed upon plant lice and other insects and rarely nibble the foliage, either in the adult or nymph stages. In the South the insect has two broods a year. As intimated above, the only damage by this insect is that caused by cutting gashes for the eggs. A long, ragged wound in the cane marks the point of egg-laying, and if this rough surface is cut away a series of longitudinal punctures will be found. Each puncture extends to the pith, and an egg is placed in the bottom of each. Infected canes, in many cases, if not broken down during the winter, fail to put out leaves in the spring.

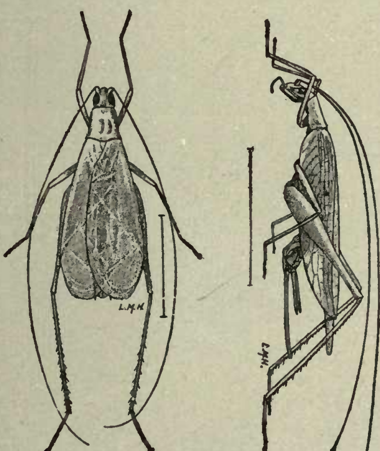


FIG. 159.—A snowy tree-cricket, male and female. (Lugger.)

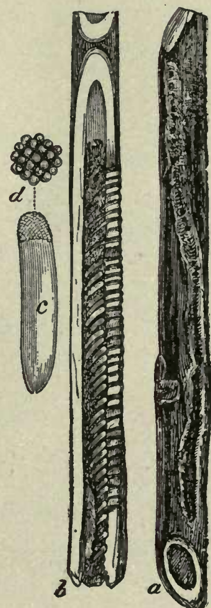


FIG. 160.—Eggs of a snowy tree-cricket: *a*, twig showing punctures; *b*, twig split open to show eggs; *c*, egg and cap, enlarged. (After Riley.)

For a most excellent account of tree-crickets the reader is urged to see Bulletin 388 of the New York (Geneva) Station,

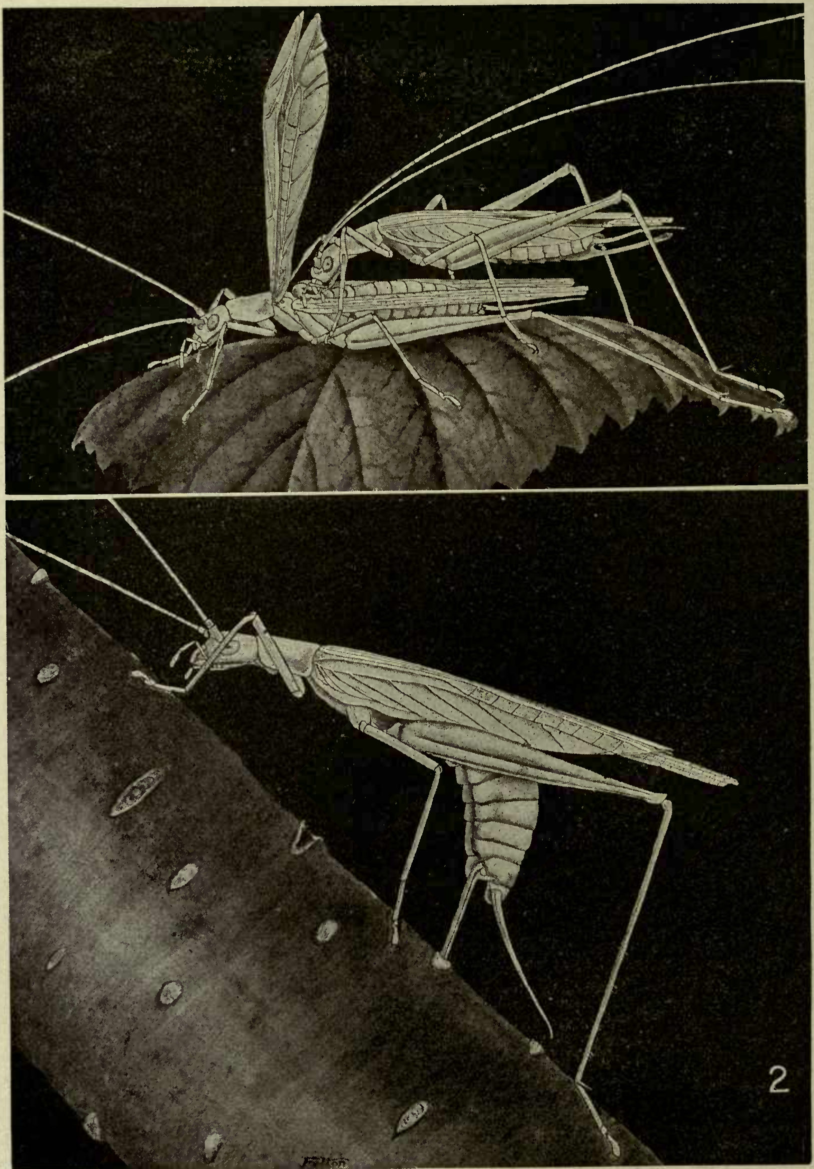


FIG. 161.—Snowy tree cricket. 1. Female feeding on thoracic gland of male at time of mating; 2. female ovipositing. (Parrott and Fulton, Geneva Bull., 388.)

Control.—Examine canes as soon as the foliage starts, at which time the injured ones may be easily detected. These should be cut out and burned. If the damage is slight, the work of this insect may be ignored, yet, if neglected, it may become injurious on account of excessive numbers.

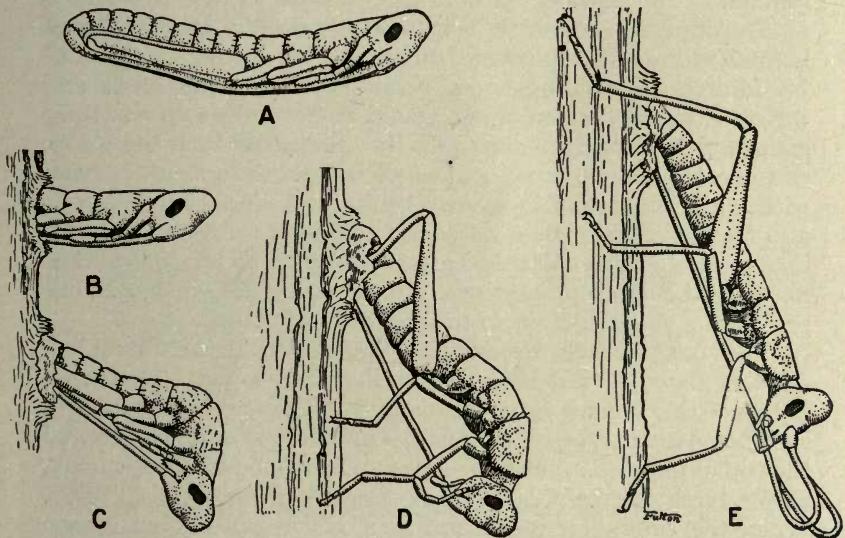


Fig. 162.—Hatching of a tree cricket: *A*, position of embryo in egg; *B*, *C*, *D*, *E*, successive stages in emergence of nymph. (Parrott and Fulton, Geneva Bull., 388.)

Attacking the Leaves.

The Raspberry Saw-fly.—The adult of this insect is a four-winged fly (*Monophadnus rubi* Harris). It deposits its eggs near the veins of the leaves and beneath the epidermal layer. The body of the larva is nearly white and thickly covered with transverse rows of white spines. The head is greenish white, with a black eye-spot on each side. After feeding upon the leaves until late in the spring, the larvæ become full grown and enter the ground to form pupal cases. They emerge as adults early the following spring.

Control.—Spray or dust with white hellebore, using one ounce hellebore to one gallon of water.

The Red Spider.—This is not an insect, but a mite (*Tetranychus bimaculatus* Harvey), as shown by the fact that the adult has eight legs, but the immature form has only six legs. It often

severely injures the productiveness of small fruits. The colorless eggs are laid in the spring on the under surface of leaves where the mites feed by sucking the juices. These mites are very small and are barely visible to an ordinary observer. The adults leave the plants in late summer and early fall and hibernate in the ground.

The injury, however, is very evident, for the affected leaves become yellowish and shriveled, finally drying up completely.

Control.—Spray the under sides of leaves with sulfur and water, in the proportion of one pound of flowers of sulfur to three gallons of water. To make the sulfur mix easily with the water, add one ounce soap to six gallons of water. A forceful spraying with a garden hose is frequently helpful. A cheap flour paste is also recommended. Use one pound of flour to a gallon of water for a stock solution. Mix the batter first, avoiding lumps, and then dilute to the above proportions. In preparing the spray, add one part of the stock solution to ten parts of water.

The Long-horned Prominent (*Schizura ipomoeæ* Doubl.).—Another name of this larva is the dingy cut-worm. The caterpillars of this species vary considerably. They are usually green, speckled with purple. Two rusty, wart-like projections occur on the top of segments four and eleven. Caterpillars feed upon oak, maple, birch, raspberry, and other plants, besides the blackberry. When the caterpillar is full grown it makes an earthen cocoon below the surface of the ground, in which it passes the winter. The moths emerge in the spring.

The adult moth (Fig. 163) is purplish gray, tinged with greenish at base and along the front edge of the fore-wings. The hind-wings are whitish in the male and grayish in the female. The expanse of the wings is a little more than one inch.

Control.—As stated elsewhere, any arsenical spray will kill a leaf-eating insect. Poison baits are also recommended. Of the arsenical sprays, arsenate of lead is repeatedly stated as safer than Paris green and has practically replaced the latter.

Attacking the Fruit of Blackberries and Raspberries.

The Raspberry Fruit Worm (*Byturus unicolor* Say).—This is a small white "worm" slightly tapering at each end and nearly one-fourth of an inch long when full grown.

Injury.—It feeds upon the leaves of raspberry and blackberry, and afterward locates inside the cup of the berry or on the recep-

tacle on which the berry is borne. Frequently, it is consumed with the berries at table.

The adult is a reddish-yellow beetle (Fig. 164) about three-twentieths of an inch long, the female laying her eggs in or on the berry.

Control.—Spray heavily with arsenate of lead, just before the emergence or at the first appearance of the beetles. Use six to seven pounds in one hundred gallons of water. This will naturally cut down the number of adults. Thorough cultivation late in the fall, close up to the bushes, is also advised, since this tends to destroy the pupæ or expose them to the extreme winter weather and to the attacks of enemies.

Fig. 163.—Moth of the long-horned prominent. (Lugger.)

Fig. 164.—The raspberry byturus. Lower figure, natural size.

Supplementary List for Raspberry and Blackberry.—A few additional insects which attack raspberries and blackberries are here listed. Those described are referred to by page numbers.

Apple-leaf hopper, p. 83
Blackberry flea-louse
Blackberry-leaf miner
Blackberry psylla
Eye-spotted bud-moth, p. 86
Oblique-banded leaf roller, p. 96
Orange-striped oak worm
Raspberry-leaf roller
Raspberry geometer
Stalk borer, p. 256
Strawberry weevil, p. 137
Tarnished plant-bug, p. 84

INSECTS INJURIOUS TO CURRANTS AND GOOSEBERRIES

Attacking the Canes.

The Imported Currant-borer.—The adult of this borer (*Sesia tipuliformis* Linn.) is a clear-winged, wasp-like moth (Fig. 165). It was introduced from Europe about 1820, and is now widely distributed and destructive over practically all North America.

Description and Life History.—The adult female is black, with three bands of yellow on the abdomen; the male is four-banded. These insects appear in early summer, at which time eggs are laid

on the bark. The caterpillar, on hatching, enters the stem and tunnels up and down the canes. This causes a yellowing of the leaves and death of the canes. They pass the winter, full grown, in the stem. At this time they are one-half of an inch long, with brown head. In the spring they transform to pupæ just beneath the bark, and soon emerge, leaving the empty skins of the pupæ projecting from the bark.

Control.—Infested canes are always easily detected and should be cut off below the injured portion and destroyed by burning; this kills the borers within. Since the bearing qualities of currant and gooseberry are improved by cutting out old canes,

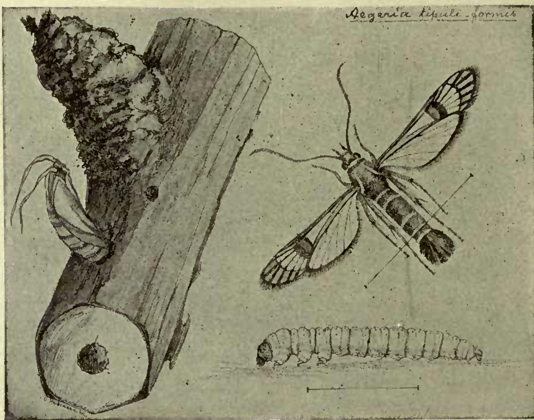


FIG. 165.—The currant borer; larva, adult, and pupal case on left. (Lugger.)

this yearly practice on the part of the growers would materially help to control this pest. These old canes should always be burned, even when borers have not been noticed.

Attacking the Leaf.

The Imported Currant Worm.—This insect is a saw-fly (*Pteronus ribesii* Scop.). The adult female is one-third of an inch long, light yellowish in color, marked with black. The male is smaller than the female and somewhat darker.

The Eggs and Larvæ.—Eggs are glued to the main ribs of the leaf, not inserted in pockets as is usual with saw-flies. They hatch in four to ten days and at first the larvæ are whitish, with dark spots on each side. As soon as the caterpillars begin to feed, this color

changes to green. After the first moult the head becomes black and the black spots on the side of the body become more prominent. The full-grown caterpillar is three-fourths of an inch long (Fig. 166). When full grown it descends to the ground, and spins a small, oval cocoon of a brownish silk among the leaves or rubbish, or even below the ground.

Two Broods.—The adults emerge from these cocoons late in June or July, mate, and produce a second brood. The adults of

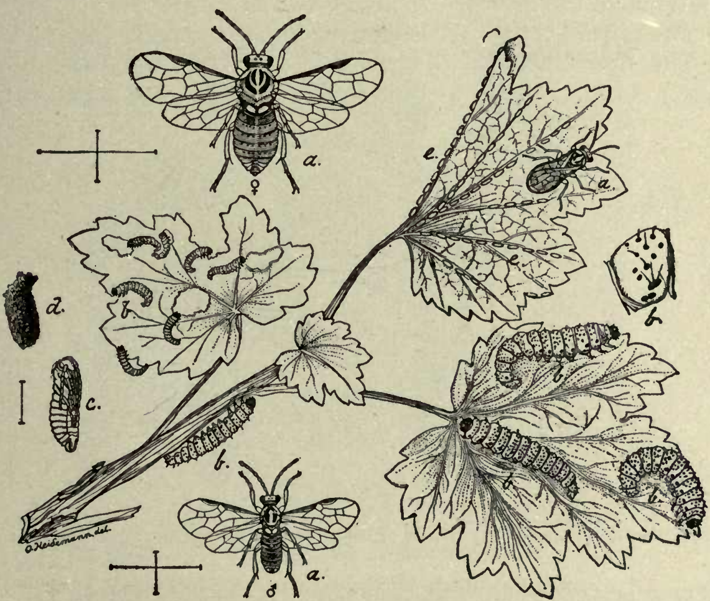


FIG. 166.—The imported currant worm: *a*, *a*, male and female saw fly; *b*, *b*, *b*, larvæ of different sizes; *c*, pupa; *d*, cocoon; *e*, eggs. (Lugger.)

this latter brood do not emerge until the following season. Since the two broods overlap, larvæ of all stages may be found during the summer.

Injury.—These, perhaps, are the most destructive of the currant pests. This is particularly so since they come in the busy part of the year and their depredations are not noticed until the currant or gooseberry bush is nearly stripped of leaves.

Control.—If the worms are observed when they first begin to feed, control is easy. Simply dust the leaves with dry, white hellebore when they are moist with dew. Or spray the foliage with the

same material, at the rate of one ounce of hellebore to three gallons of water. Before the fruit is set, and also after it is picked, arsenate of lead is cheaper and more effective as a spray material.

The Native Currant Worm.—The greenish caterpillars of this saw-fly (*Pristophora gossulariæ* Walsh) appear on currant and gooseberry leaves in the spring. They feed on the leaves until full grown and pupate among the twigs. The adults are black, four-winged flies. The females deposit their eggs under the epidermis of the leaves. There are two broods a year.

The control is the same as for the imported currant worm.

The Four-lined Leaf-bug.—This bug (*Pœcilocapsus lineatus* Fabr.) is widely distributed in North America. Its upper surface

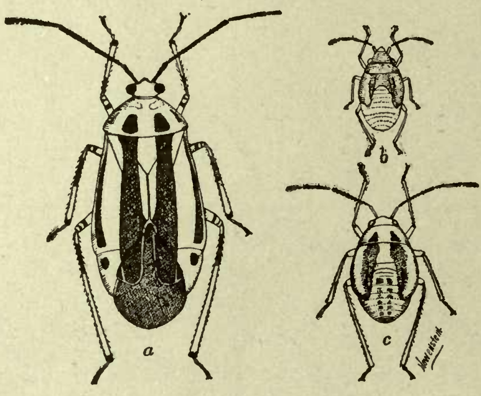


Fig. 167.—The four-lined leaf-bug; *a*, adult; *b* and *c*, nymphs. (After Slingerland.)

is green or yellowish, with four black stripes. The tips of the wing-covers are black. The body is a bright orange yellow (Fig. 167). The nymph, when newly hatched, is one-twentieth of an inch long; bright red, marked with blackish spots. When full grown this nymph is one-fifth of an inch long. Eggs hatch in late spring. The nymphs require from seventeen to twenty days to complete their growth.

Injury.—This insect preys upon a long list of plants, but is particularly injurious to currant and gooseberry. Attacked leaves appear spotted, turn brown, curl up, become brittle, and are torn and broken by the wind. Shoots bearing these leaves are checked in growth and frequently droop and die. Dahlias and roses are often injured; in fact, it is a marked enemy of these two plants.

Control.—The nymphs may be killed by spraying with kerosene emulsion. But the tobacco extracts are particularly recommended. It is to be noted that the adults are not susceptible to treatment. Both nymphs and adults will drop when disturbed.

The Yellow-bear Caterpillar is injurious to berries, currants and gooseberries as well as to many other plants. See the discussion on page 160, under Grape Insects.

The Currant Plant-louse.—This aphid (*Myzus ribis* Linn.) sucks the juices from the leaves of the currant, causing them

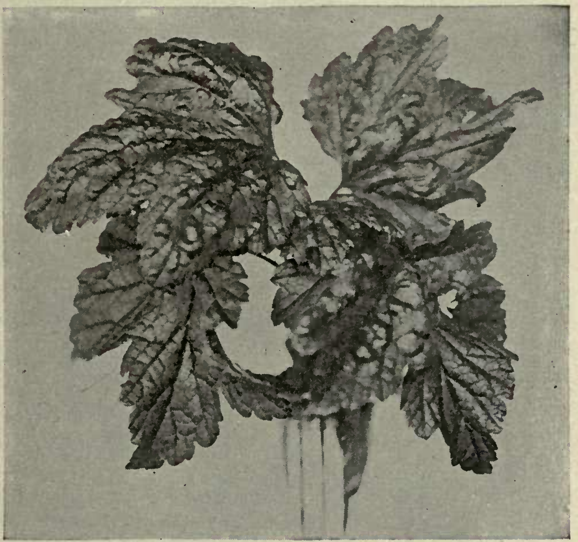


FIG. 168.—Currant leaves infested with lice. (Lugger.)

to curl and form incomplete galls, inside of which the lice stay. Their presence on the under side of the leaf is indicated by the striking red color on the upper surface (Fig. 168). In midsummer they migrate to some other plants for food or become greatly reduced in numbers by parasites and predaceous insects.

Description.—The winter is passed in the egg stage, like many other aphids, these eggs hatching when the foliage appears. The wingless females are one-twelfth of an inch long; green or yellowish green, mottled with darker shades. The eyes are bright red. The winged females are slightly larger than the others.

Control.—When remedial measures are called for, the under side of the leaves should be sprayed with whale oil soap or other strong soap. Use one pound to six gallons of water. Or spray with tobacco extracts. The spraying must be done before the foliage becomes badly curled, or the insects will not be hit. Picking off curled leaves by hand and destroying them will keep the pests somewhat in check.

The Spiny Currant Caterpillar (*Polygonia comma* Harr.).—The caterpillars, when full grown, are about one and one-fourth inches long. They vary from light brown to greenish yellow in color and are marked with black and yellow lines. Upon the body are numerous branched spines, varying in color from dark brown to a yellow. The spines are frequently tipped with black.

The adult insect is the common and strikingly handsome butterfly which hibernates in some sheltered spot and is frequently seen in warm places very early in the spring. The illustration (Fig. 169) serves to give a good idea of this species. The wings are quite irregular in outline, and there are many projecting points and notches. The surfaces of all four wings are reddish brown, bordered on the outer edge with darker brown. The color of the hind-wings varies considerably in intensity, and more so on the under side, which is usually dark brown, with many grayish lines and streaks. The butterfly may always be recognized by a plainly marked "C" on the lower surface of the hind-wing of a metallic silvery color. One's imagination might picture this mark as a comma.

Life Cycle.—Eggs are laid singly on the leaves of currant and gooseberry, and here the solitary larvæ are found. When full grown the caterpillar seeks a secluded spot to change to pupa or chrysalis. The chrysalis is frequently seen hanging from leaf or twig. It is brown in color. In ten days, from this formation, the butterfly emerges.

There are generally two generations of caterpillars—one in late spring and another one in late summer or early fall.

Injury.—The caterpillar is a general feeder, attacking not only wild and cultivated currants and gooseberries, which it prefers, but is also fond of elm, hop, nettle, basswood, and various other growths.

Control.—Arsenical sprays or white hellebores are effective, if any remedy is needed. The hellebore is preferable if the fruit is ripe or nearly so. Recourse may also be had to hand-picking.

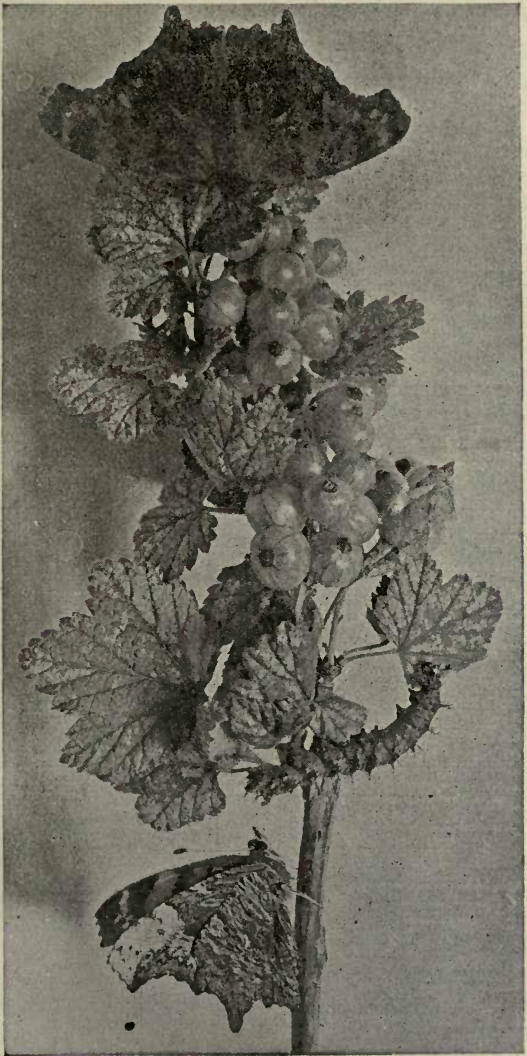


FIG. 169.—Spiny currant caterpillar and two butterflies. (Lugger.)

The red spider is a small mite seriously injuring many kinds of plants. For discussions and treatment, see pages 215, 221. See also greenhouse pests.

Attacking the Fruit.

The Currant Fruit Fly.—This is a pale yellowish brown fly (*Epochra canadensis* Loew.) of medium size, with dark bands on the wings. It deposits eggs in the skin of the half-grown fruit. The young maggots eat into the seeds, causing the berries to become discolored, to turn red prematurely, and fall to the ground. The full-grown maggots emerge from the fruit, pupating in the ground, and come forth as adults the following spring.

Control.—Spraying is not effective for this insect. Where practicable, the ground should be worked early in the spring and late in the fall. If the bushes are not too numerous, the injured fruit might possibly be removed and destroyed. Poultry might be allowed to run among the bushes early in the fall and would scratch up and eat many insects in the hibernating stage.

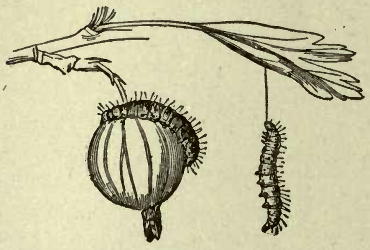


Fig. 170.—The gooseberry fruit worm.

The Gooseberry Fruit Worm (*Zophodia grossulariæ* Pack.).—These worms cause fruit of both gooseberry and currant to become discolored and ripen prematurely. If it is attacked when quite young, the fruit becomes whitish and withers. Currants are not, ordinarily, large enough to hold this larva and therefore they are drawn together in clusters and the worm lives within the web-covered enclosure. Figure 171 gives a very good idea of the work of this pest of currant and gooseberry.

Life History.—This pest (Fig. 170) is the young of a pale-gray moth, the wings of which expand one inch. The adult appears early in the spring, depositing eggs on the young currants or gooseberries shortly after the fruit is set. It changes to a pupa in the ground, spinning silken cocoons among the rubbish for the winter, emerging the following spring.

Control.—The same remedies employed against the currant fruit fly are applicable to this pest.

Supplementary List for Currant and Gooseberry.—The following insects are also found attacking currants and gooseberries. The pages cited give full discussions of these.

Apple-leaf hopper, p. 83
Cottony maple scale, p. 287
Currant scale
Io emperor moth, p. 128
Oblique-banded leaf roller, p. 96
Saddle-backed caterpillar
San José scale, p. 70
"Stink" bugs
Tarnished plant bug, p. 84
Well-marked cut-worm moth, p. 97

Fig. 171.—Injuries to currants by gooseberry fruit worm. (Parrott and Hodgkiss, Geneva Bull., 423.)

INSECTS INJURIOUS TO THE GRAPE

Attacking Roots and Vines.

The Grape Root Worm (*Fidia viticida* Walsh).—This is one of the most serious pests of the grape in many parts of the United States. Grubs, by destroying the roots, may completely ruin a vineyard (Fig. 172).

Description and Life History.—The adult of this grub is a small brownish beetle with hairy coat. The beetles emerge during the summer, beginning at once to feed, eating chain-like holes in the

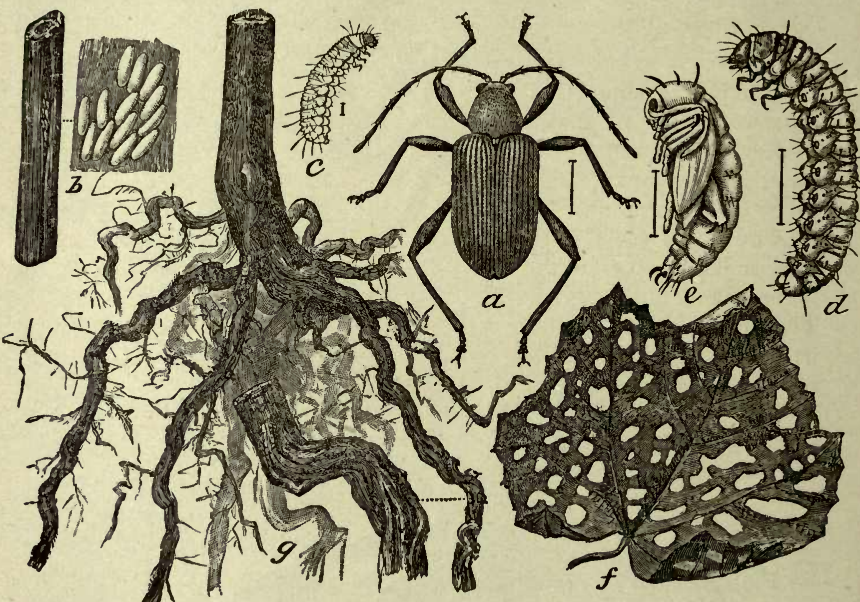


FIG. 172.—Different stages of grape root worm. (U. S. Bu. Ent.)

grape leaves, apparently preferring young plants. They have also been reported eating the skin from the fruit. When disturbed, they endeavor to conceal themselves.

The female deposits from sixty to one hundred eggs during the season, evidently at three different periods, from twenty to forty being laid at one time. These eggs are yellow and are placed in clusters under the loose bark or in crevices on the canes. They hatch in from eight to ten days. The grubs, upon hatching, fall to the ground, entering the soil, and make their way to roots where

they feed. They are, for the most part, full grown before winter, reaching a length of about one-half inch. They come to the surface in spring, form earthen cells, pupate, and emerge as adults a few weeks later.

Control.—Cultivate early to destroy the pupal cells. Spray for the adult with arsenate of lead. Use three pounds of lead arsenate in fifty gallons of water. Add one gallon of molasses or cheap syrup to sweeten the mixture. The adult beetles may be jarred from the leaves on sheets placed beneath the vines.

These measures may, for the most part, also be recommended for the moth known as the grape-vine root worm.

Attacking the Leaves of the Grape.

The Grape-vine Flea-beetle.—The adult of this insect (*Haltica chalybea* Illiger) is a steel-blue beetle appearing in early spring, feeding on the first-appearing buds. It is a voracious eater, and is most active during the heat of the day. When disturbed, it drops to the ground.

Life History.—Eggs, according to Slingerland, are laid side by side, tucked into cracks in the bark, some in cavities eaten into the buds. They hatch about the time the young leaves are expanding. The small, dark brown grubs feed on the young leaves, eating irregular holes from the upper side. They become full grown after several moults, which require from three to four weeks. They then fall from the leaves and enter the ground about one inch, forming a smooth cavity in which they pupate. They remain in the pupal stage about one or two weeks, appearing as adults in midsummer, at which time they feed to some extent on grape leaves. The winter is passed under any protecting litter. Figure 173 illustrates this insect.

Control.—Keep the vineyards free from rubbish in the winter. As soon as the work of the beetles is noticed on the buds, spray with arsenate of lead. Use six pounds to fifty gallons of water. Vineyards regularly sprayed with arsenicals and well cultivated show but little injury from this insect. Beetles may also be jarred on sheets or into large pans and then killed.

Grape Cane-borer.—This widely distributed insect (*Schistocerus hamatus* Fab.) is also known to attack the twigs of apple. It was described by Say and named *Amphicerus bicaudatus*, as a distinct insect, but these are now shown to be identical. It tunnels and kills young shoots of grapes in the spring. It also works in peach and pear, and to some extent in shade trees.

Life History.—The eggs are probably laid in the spring. The full-grown grub transforms to a pupa within the burrow, the adult escaping by gnawing through the walls of its tunnel. The beetle (Fig. 174) is dark brown, not quite one-half of an inch long, with a head drawn under and below the thorax (Fig. 174). It may pass the winter in the adult stage within the burrow, emerging in the spring, or may issue from the twigs of the grape and hibernate in a tunnel which it makes in fruit trees.

Control.—One should cut out and burn in spring all diseased and dying twigs. By fall pruning of the grape, and burning of all cuttings, affected vines may be relieved.

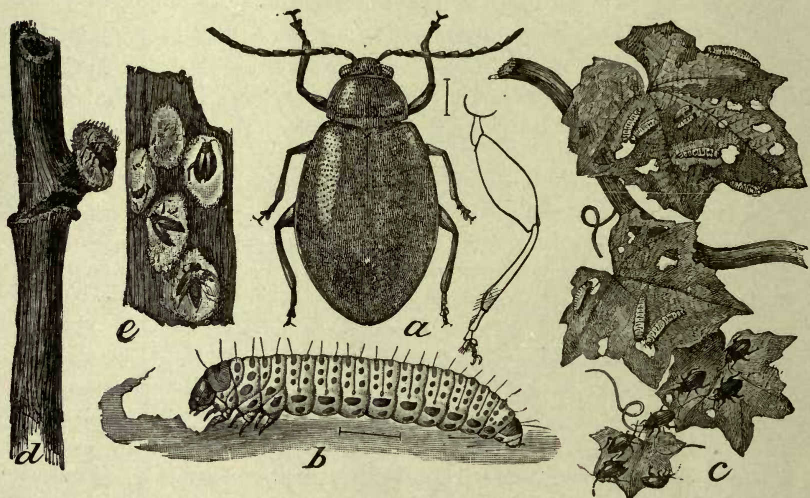


FIG. 173.—The grape-vine flea-beetle, different stages. Hair lines indicate natural size. (U. S. Bu. Ent.)

The Rose Chafer (*Macrodactylus subspinosus* Fab.).—This small beetle appears at times in swarms and attacks the grapes about blossoming time. It is awkward-appearing, yellowish and brownish, and more or less hairy. The eggs are deposited in the ground during spring and early summer. The larvæ (Fig. 175) look somewhat like small white grubs. They feed on grasses; live over winter as larvæ; turn into pupæ in the spring, and soon appear as adults.

A Toxic Principle.—This beetle is interesting in that for a long time it was supposed that the death of fowls after eating them was

due to spiny projections on the legs of the insect. It has now been demonstrated that the death of fowls and other animals, including trout, feeding upon these beetles, is not due to mechanical irritation, but to a toxic principle existing in the beetle.

Control.—Poisons are not generally satisfactory, but the following spray is quite effective. Use ten pounds arsenate of lead, twenty-five pounds cheap molasses or confectioners' glucose or

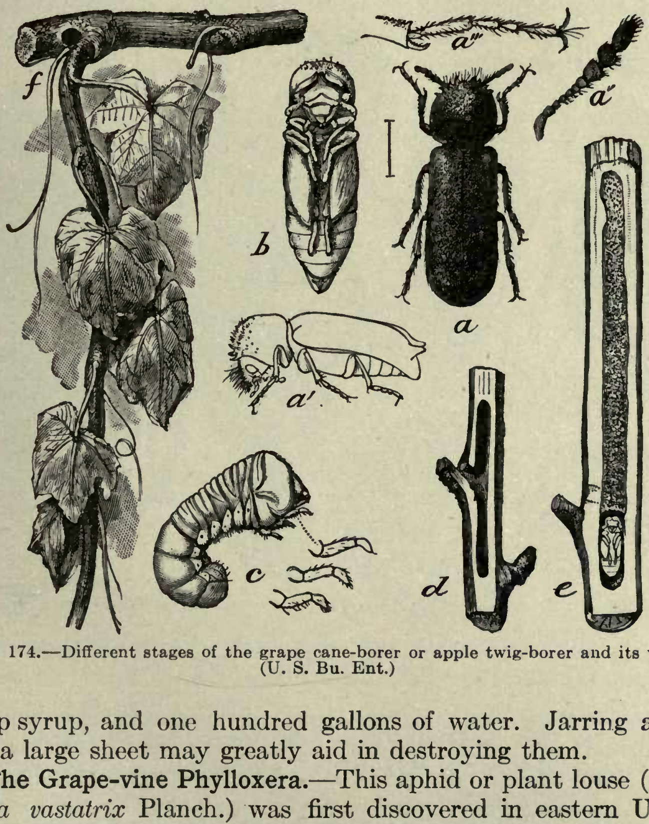


FIG. 174.—Different stages of the grape cane-borer or apple twig-borer and its work. (U. S. Bu. Ent.)

cheap syrup, and one hundred gallons of water. Jarring adults into a large sheet may greatly aid in destroying them.

The Grape-vine Phylloxera.—This aphid or plant louse (*Phylloxera vastatrix* Planch.) was first discovered in eastern United States on wild grapes and was introduced into France early in the 1860's. There it became a most serious enemy to grape-raising. It exists in several forms and is found on both roots and leaves.

The female is plump, orange yellow, wingless, and fills the gall in which she lives with her eggs (Fig. 176). The female root form

is one twenty-fifth of an inch long; light greenish yellow in summer, and darker in winter. When they are numerous on the roots there is an appearance as if the roots were dusted with mustard.

Life History.—There are really four forms to be observed in the life history of this plant louse: (1) the leaf-gall form; (2) the root form, which is the most destructive; (3) the winged or colonizing form; and (4) the sexual form. Winter eggs are deposited in the fall on bark or wood. They hatch in the spring, and the

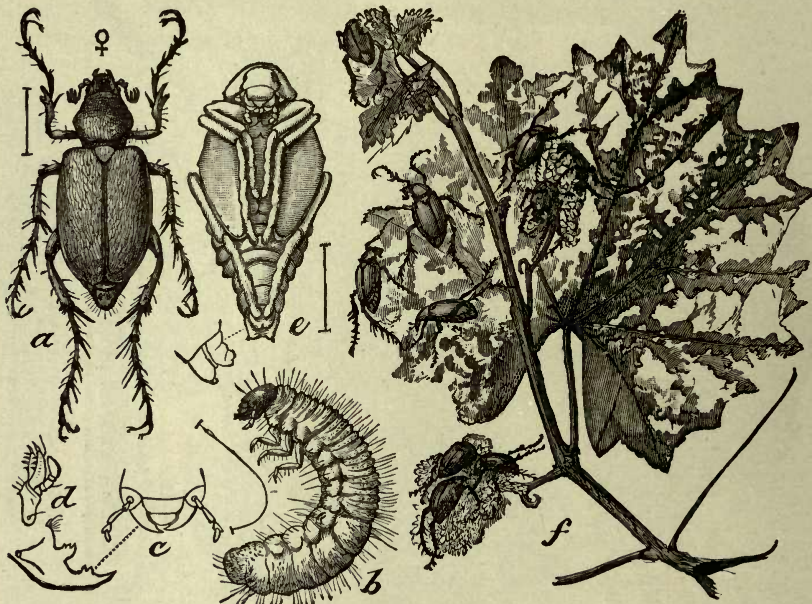


Fig. 175.—The rose-chafer or rose-bug; different stages, details of structure and injury to grape leaf. (U. S. Bu. Ent.)

young, settling on the leaves, cause galls on the lower side. These are all females, which die after laying their eggs. In about eight days these eggs hatch into females like the parent, which migrate and form new galls. There may be six or seven generations during the season. Many migrate to roots during the spring and summer, and they all seek the roots at the approach of winter. The last generation takes no food, and each female lays one egg, which passes through the winter.

The next spring the roots are attacked and the females multiply

upon them also. Some at this time develop into winged females, which escape from the soil and fly to neighboring vines and lay eggs which hatch into males and females. This is the only sexual generation in the whole life cycle.

Injury.—This is a serious pest of the grape, as above intimated. The galls on the roots are frequently accompanied by a rotting of the plant tissue. It is not so destructive, by any means, in America as in Europe. Most varieties of grapes grown here are resistant, yet in California it is regarded as an important pest of the grape.

Control.—The general recommendations are to use resistant vines. There is a marked variation in the resistance of different

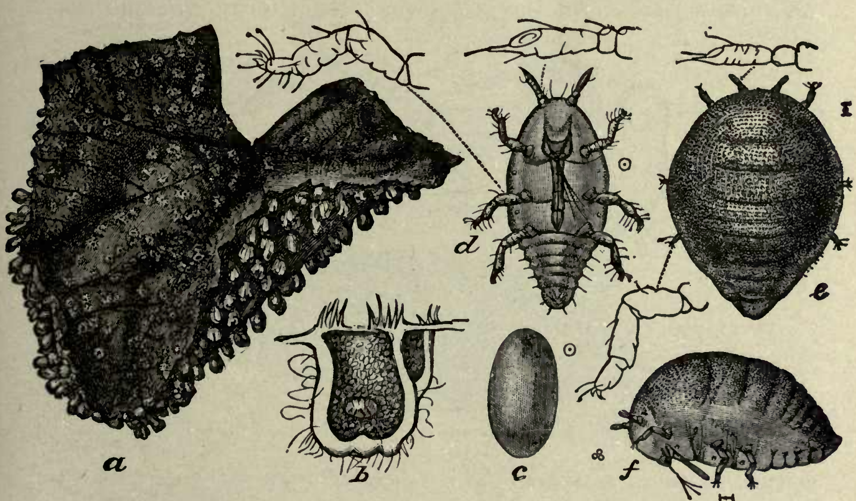


Fig. 176.—The grape-vine phylloxera, leaf form. (After Marlatt, U. S. Bu. Ent.)

species and varieties. Not all varieties can be used as stock for desired scions. As is well known, the wild grape of America makes good stock for roots.

On deep loose soils carbon bisulfid may be used against the root form, but not on clay nor on dry, rocky hillsides. This treatment is hardly practical and has met with only indifferent success. Treatment with carbon bisulfid is rather expensive, costing from $15 to $25 per acre. It is applied by pouring one-half to three-fourths of an ounce of the liquid into holes a foot deep. The holes are made from eighteen to twenty-four inches apart, and not nearer than one foot to the vine.

Submersion of the roots in water, if the latter is available, is effective. It is suggested that, where possible, an affected vineyard be flooded with six inches of water for from seven to ten days, as soon as the vines cease growing in the fall. Infested vines are benefited also by two days' flooding in midsummer, but are injured by any more. Vines on sandy soil are rarely injured by this pest.

The Light-loving Anomala.—Beetles of this group (*Anomala lucicola* Fab.) attack leaves of grape and of Virginia creeper. They are yellowish or brown beetles about one-third of an inch long. There is considerable variation in color and markings of the adult. The larval stage is spent in the ground as a white grub, feeding on various roots. Another somewhat larger form, *A. marginata*,

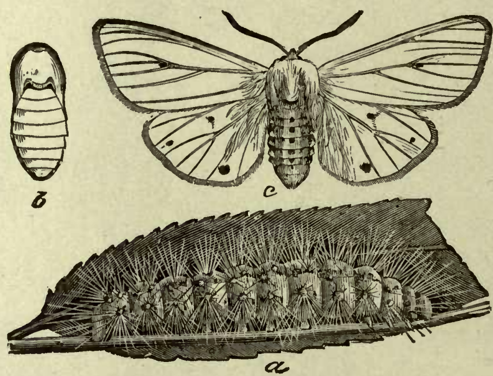


Fig. 177.—The yellow-bear caterpillar, moth, and pupa. (After Riley.)

occurs in some sections. These beetles frequently destroy the leaves of the grape.

Control.—Spray with arsenate of lead, four pounds to fifty gallons of water, when there is no fruit on the vines.

The Yellow-bear Caterpillar.—The adult moth of this species (*Diacrisia virginica* Fab.) is often called "the white miller." It is of a white color, marked with a few dots. The expanse of wing is about one and three-fourth inches.

Description and Life History.—There are two generations—the second brood of caterpillars appearing in late summer or early fall. When full grown, these striking caterpillars are two inches long, generally yellowish, but the colors vary from yellow to brown in the same brood (Fig. 177).

The female places her round, yellow eggs in clusters on the

under side of leaves. These eggs hatch in a few days into small, yellow caterpillars, which, for a time at least, are gregarious, and eat only the under sides of the leaves. Later they scatter and feed on all parts of the leaf. When full grown the hairy covering of the body is worked into a silken cocoon in which the chestnut-brown chrysalis is formed. The two broods intermingle so that the insect is present, in one form or another, from spring to autumn. It is a common and rather serious pest and something of a general feeder.

Control.—When in moderate quantities it may be hand-picked. If numerous, use arsenate of lead spray as strong as four

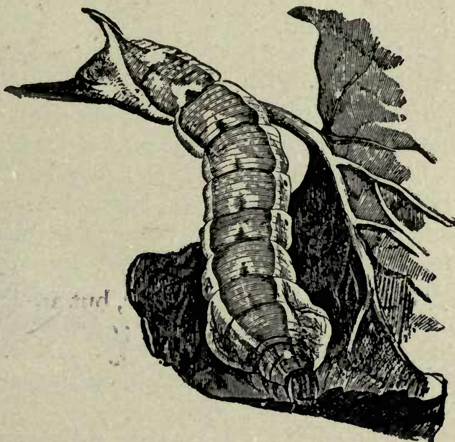


FIG. 178.—The hog caterpillar of the grape. (After Riley.)

pounds to fifty gallons, since the caterpillars are thoroughly resistant.

The Grape-vine Hog Caterpillar (*Ampelophagus myron* Cram). —These caterpillars are very destructive to foliage of the grape, and are also said to bite off stems of unripe grape clusters, causing them to fall.

The chrysalis is formed in clusters of leaves which are bound together with a silken thread.

The adult moth has long and narrow wings, expanding two and one-half inches. The front wings are olive green, crossed by bands of greenish gray. The hind-wings are dull red, shading to greenish gray next to the body.

The caterpillar (Fig. 178) is two inches long, green in color,

covered with minute yellow tubercles or blue dots. There are seven oblique yellow spots on each side the body, margined with green. There is also a white stripe from the back of the head to horn on the posterior end, on each side; a series of seven dots along the middle line, the color of dots varying from red to lilac and each dot set in a yellow patch. It is two-brooded, and pinkish individuals are found in the second brood of caterpillars.

Control.—These conspicuous caterpillars are not numerous. Hand-picking may be sufficient; but spraying with arsenicals may be resorted to if thought necessary.

The White-lined Sphinx.—This large, handsome moth (*Deilephila lineata* Fab.) may be seen about twilight, hovering before flowers like a humming bird.

Description.—The ground color of the fore-wings is a rich greenish olive, with a pale buff stripe along the middle of the wings from the base to near the tip. There is a gray band on the margin of the fore-wings, and the veins are margined with white. The hind-wings are small, crossed by a wide, rosy band. There is a line of white on each side of the body, from the head to the first abdominal segment. The abdomen is olive, with white and black spots. The wing expanse is about three and one-half inches (Fig. 179).

The caterpillars vary somewhat in color, but are often yellowish green, with a row of prominent spots along each side. The breathing pores on each side are margined with black or black with yellow edges.

Life History.—The adult moth appears in the spring and again in the fall, the insect being two-brooded. The caterpillars may be found on the grape, or more commonly, perhaps, on turnip, buckwheat, and frequently on apple. When the caterpillar is mature, it buries itself in the soil in a smooth cavity and changes into a light-brown pupa. Winter is passed by the pupæ of the second brood.

Control.—This is not a serious pest, but the larvæ are voracious eaters when present. Hand-picking is probably as practical as any method. They are held well in check by attacks of a tachinid parasite.

The Grape-leaf Skeletonizer or American Procris.—The caterpillars of this moth (*Harrisina americana* Guer.-Men.) are gregarious, feeding with their heads all toward the margin of the leaf. They are black and yellow in color and six-tenths of an inch long

when full grown. When their growth is finished, they become yellow, with a transverse row of large spots on each segment, and are slightly hairy.

In late summer, when ready to transform, they disperse. Each seeks a sheltered spot, where a tough, oblong cocoon is constructed, in which the caterpillar changes to a shiny brown pupa for the winter season.

The adult emerges the following spring. This insect has proba-

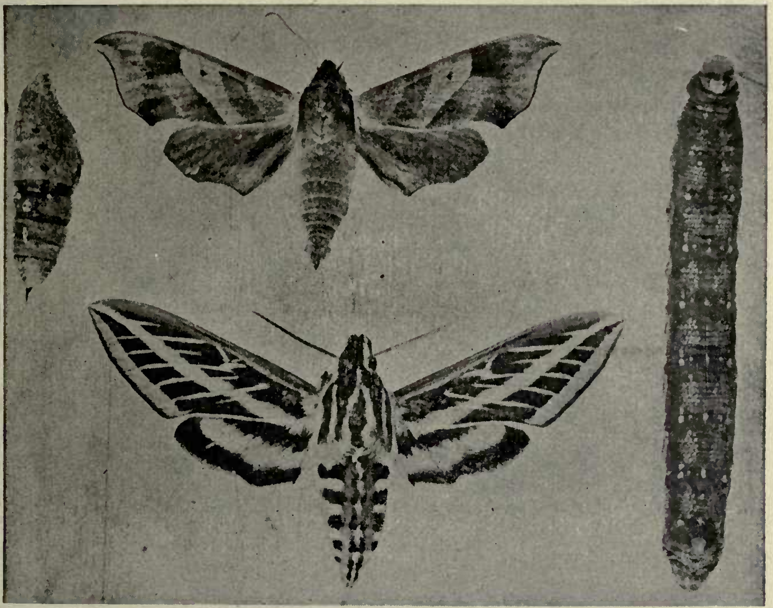


Fig. 179.—Two sphinx moths which are enemies to grapes: above, *Ampelophaga myron* and pupa; below, *Deilephila lineata* and larva. (After Lugger.)

bly two broods in some sections. The female moth is about one-half inch long. It is bluish to greenish black, with an orange-colored collar. Its flight is slow and unsteady. Eggs are deposited on the outer side of leaves.

Injury.—The caterpillars eat the soft tissues of the foliage, but not the veins. As they grow, the smaller veins are eaten, leaving only the larger ones not attacked. This insect may become quite injurious if occurring in numbers (Fig. 180).

Control.—Hand-pick the leaves on which colonies are feeding.

Arsenate of lead may be used as a spray if the fruit is not too near the ripening stage.

Grape-vine Leaf-hoppers.—There are three species of the genus *Typhlocyba.* Perhaps the most important is *T. vitis* Harr. The adults of these three species of leaf-hoppers are all similar in shape and general appearance, differing in minor markings. *T. vulnerata* is a reddish-brown insect, marked with white lines

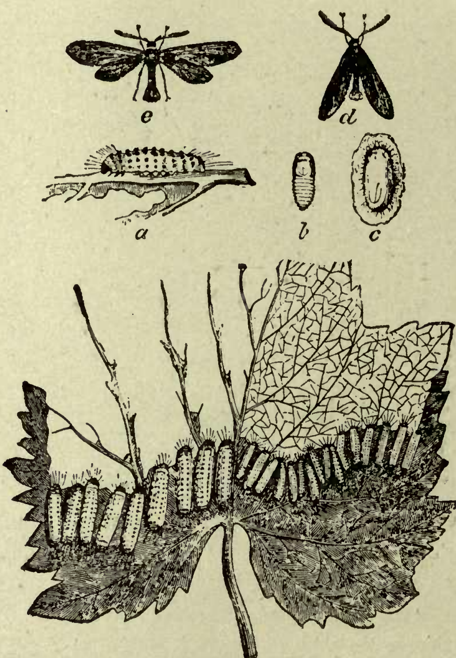


Fig. 180.—The American procris: *a*, caterpillar; *b*, pupa; *c*, cocoon; *d* and *e*, moths. Below, a colony of caterpillars feeding. (After Riley.)

and dots, with two prominent black lines at the margin of the upper wings. *T. comes* is of a translucent white color, marked with red lines and prominent black spots at tip of wings and two black lines at the margin. These nymphs hatch in midsummer or early fall, they hibernate as adults, and in spring attack the leaves of the vines as soon as the foliage appears. The life history as well as the occurrence of these species varies in different parts of the country.

Leaf-hoppers are regarded as among the most destructive of grape-vine pests, sucking sap from the leaves and thus greatly weakening the vines. A party in California has estimated his loss on one thousand acres at ten thousand dollars in one year (Fig. 181).

Control.—Remove all rubbish in the field and rake or lightly cultivate the ground. The nymphs or young, being all on the under

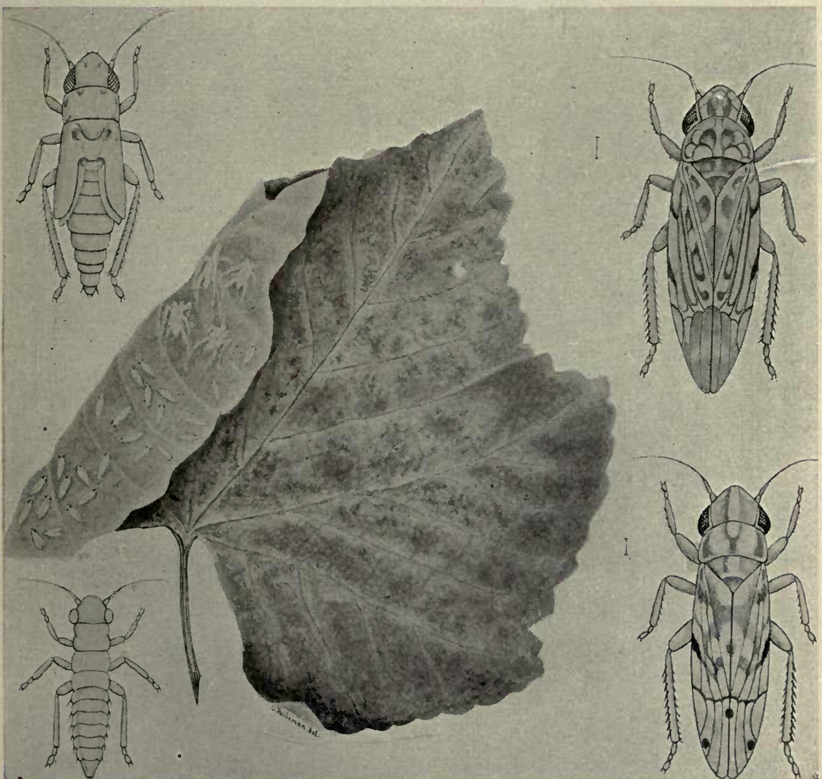


FIG. 181.—A grape-vine leaf-hopper, different stages. (Lugger.)

side of the leaves and not capable of flight, may be sprayed with whale oil soap solution or the resin spray. Use one pound of soap to fifteen gallons of water in the former case. The resin spray is made by adding one pound of resin to fifteen gallons of hot water and enough lye or potash to completely dissolve the resin. This generally takes one pound of lye to eight pounds of resin. The

spraying should be done forcefully from below. It should be borne in mind that this treatment kills only those insects which are hit with the spray, the adults escaping by flight.

FIG. 182.—The eight-spotted forester. (Lugger.)

The Eight-spotted Forester (*Alypia octomaculata* Fab.).—This is a strikingly handsome moth (Fig. 182), with a wing expanse of from one to one and one-half inches. It is bluish black in color,

marked with eight large light spots—two spots on each wing. Those on the fore-wings are pale yellow, while those on the hind-wings are white or whitish.

The caterpillars are light brown in color, with many black lines and an orange band across each segment. The head and

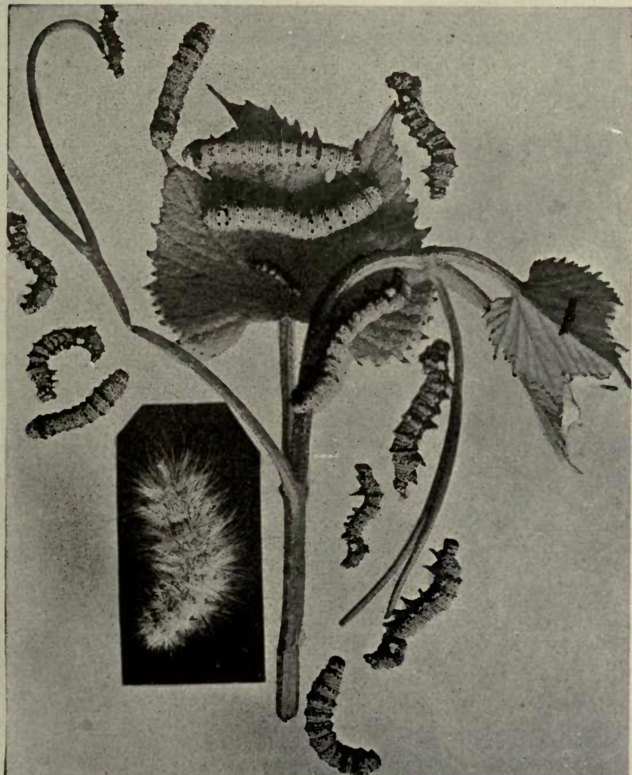


FIG. 183.—Larvæ of eight-spotted forester. On black ground, a parasitized "yellow bear" caterpillar. (Lugger.)

dorsal shield of the first segment are shining bright orange, marked with dots. There are eight black conical, elevated tubercles on the orange band of each segment in the middle region.

These caterpillars (Fig. 183) feed quite commonly on the grape and on the Virginia creeper. The species is commonly found throughout the United States and Canada.

Control.—An arsenate of lead spray is the most efficient remedy.

Attacking the Fruit.

The Grape Curculio (*Craponius inæqualis* Say).—This beetle (Fig. 184) is black in color, sprinkled with grayish spots, and is one-tenth of an inch long. It hibernates in the adult stage, and eggs are laid on the young grapes in early summer.

Injury.—The larva or grub, upon hatching, enters the fruit and feeds within. Its presence causes a discoloration of one side of the berry as of premature ripening. The berry remains plump, but sometimes drops before becoming ripe. The grub, becoming full grown before the crop ripens, leaves the berry, drops to the ground, and buries itself a short distance below the surface. It changes to a pupa, from which the beetle escapes some time in September or October.

Fig. 184.—The grape curculio.

Control Measures.—Jar the vines occasionally in June, placing a sheet on the ground beneath to catch the weevils, which can then be destroyed.

The Grape-berry Moth.—This insect is a serious pest in vineyards, and the injury it causes resembles that of the grape curculio.

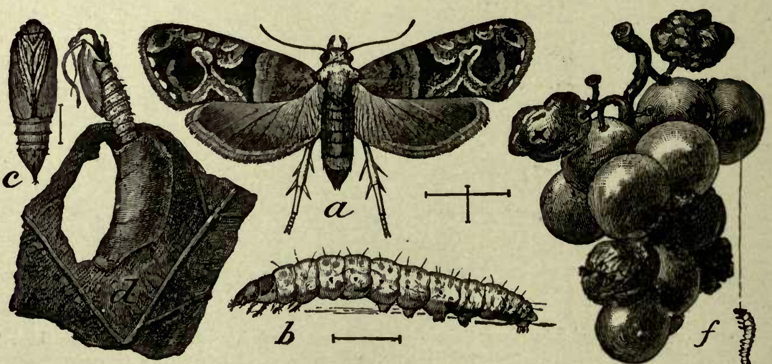


Fig. 185.—The grape-berry moth: *a*, *b*, larva; *c*, pupa; *d*, case with empty pupal skins; all enlarged; *f*, grapes with worm, natural size. Hair lines indicate size of *a*, *b*, *c*, and *d*. (U. S. Bu. Ent.)

The pest when a moth (*Polychrosis viteana* Clem.) has fore-wings of a pale, dull bluish shade, and hind-wings dull brown.

Injury.—The caterpillar enters the grape early in July, produces a discolored spot; and spores entering the grape at the puncture

cause rotting of the fruit (Fig. 185). Sometimes several grapes are bound together by silken threads and fed upon by one insect. The first generation of caterpillars may also feed upon the blossoms.

Transformations.—When the larva is full grown, and ready to pupate, it forms a cocoon on the leaves of the vines by turning over the edge of a leaf and lining the inside with silk. There are two broods of this insect, the spring brood being sometimes found on weeds.

Control Measures.—Since the winter is probably passed in the pupal cases attached to leaves, gathering and burning the leaves will materially diminish their numbers. All diseased and fallen fruit should be destroyed. Wormy grapes might be picked off the vines in summer at an expense of about two dollars per acre. Vineyards sprayed with a combined fungicide and arsenical poison before blossoms open are not seriously affected with this pest.

Supplementary List of Grape Insects.—Besides the insects described in this section of the chapter, the following also attack the grape less seriously. Where page citations are given a discussion of the insect may be found.

Abbot sphinx
Achemon sphinx
Cottony maple scale, p. 287
False chinch bug
Grape plume moth
Grape-vine leaf-folder
Grape-vine leaf-sewer
Indian euphoria, p. 106
Mealy flata
Pandorus sphinx
Pyramidal grape-vine caterpillar
Red-shouldered simoxylon
Saddle-back caterpillar
Smeared-dagger-moth
Snowy tree-cricket, p. 140
Spotted vine-chafer

INSECTS INJURIOUS TO THE CRANBERRY

Attacking the Leaves.

The Cranberry Leaf-folder (*Peronea oxycoccana* Pack.).—This is a small moth, having a spread across the wings of only three-fourths of an inch. The fore-wings are reddish brown and the hind-wings glistening gray, the body being a dark slate color.

The method of control employed in the New Jersey cranberry district is to keep the bogs covered with water until after the middle of May, compelling the moths to lay their eggs on other plants belonging to the same family. This practice aids greatly in controlling other cranberry insects. One spraying with arsenate of lead will effectually destroy them if applied when the eggs of the second brood are hatching. Use five or six pounds in fifty gallons of water.

The Yellow Cranberry-worm (*Teras vacciniivorana* Packard).—This pale yellow caterpillar (Fig. 186) is about three-tenths of an inch long and feeds on the foliage of the cranberry. It draws leaves of the plant together with silken threads, feeding upon their upper surfaces.

Control.—Flooding is recommended as the most effectual remedy. The vines should be kept under water for two or three days. Fires lighted in the neighborhood will attract and destroy some of these moths. Where possible, a thorough spraying with arsenate of lead, at the rate of five pounds to fifty gallons of water, at the time of hatching of the eggs of the second brood will clear a badly infested bog for three or four years. The time for spraying varies with the season; usually it should be done about the middle of summer.

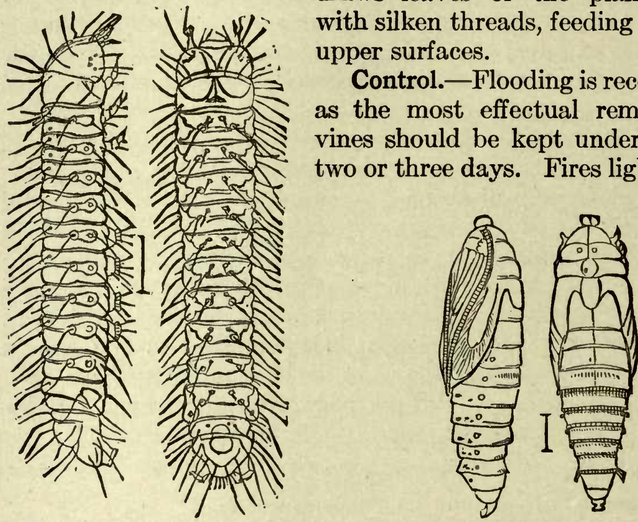


FIG. 186.—The yellow cranberry worm, dorsal and side views of larva and two views of pupa.

FIG. 187.—The cranberry leaf-roller.

The Cranberry Leaf-roller (*Archips parallella* Rob.).—This is another caterpillar which feeds upon the foliage of the cranberry. It is reddish in color, with a yellow head. It is about three-fourths of an inch long, with a number of prominent warts on the back. From each wart one or more rather long, stiff hairs project. The moth (Fig. 187) is a reddish orange; the fore-wings are crossed diagonally with numerous fine lines of a darker reddish brown.

Control.—Apply the same remedies as given for the cranberry leaf-folder.

The Cranberry Spittle Insect.—This is a small, soft, sucking

insect (*Clastoptera proteus* Fitch) found in the spring in small masses of froth-like secretion growing upon the shoots of the cranberry. When mature the insect jumps like a flea. The vine is weakened by the loss of sap.

Flooding is recommended.

Attacking the Fruit.

The Cranberry Fruit Worm.—The caterpillar (Fig. 188) of this moth (*Mineola vaccinii* Riley) is yellowish green in color. The injury caused by it takes place in late summer, when it enters the berries, eating the contents and causing them to turn prematurely red. In the fall it becomes fully grown and buries itself in the ground, where a cocoon is formed, covered with grains of sand.

As with the preceding insect, flooding appears to be the only remedy.

The Cranberry Weevil.—This is a reddish-brown beetle (*Anthonomus suturalis* Lec.) with a dark-brown head and a beak or snout half as long as its body (Fig. 189). The complete length of the insect, including the beak, is a little over one-eighth of an inch.

Fig. 188.

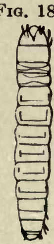


Fig. 189.

Fig. 188.—The cranberry fruit-worm.
Fig. 189. — The cranberry weevil.

It selects an expanding blossom bud, drills a hole into it with its snout, and lays in the hole so made a pale yellow egg. The bud is then cut off by the beetle, and, lying upon the ground, furnishes shelter and food for the grub, which completes its transformation within. Finally the new beetle emerges from a round hole in the side of the decaying bud.

Flooding with water is the remedy advised.

QUESTIONS

1. What do you regard as the most injurious insect enemies of strawberry growers?
2. Give life history and remedies for the strawberry root-louse.
3. Discuss the work of white grubs in connection with strawberries.
4. Give life history and remedies for the strawberry weevil.
5. What insects, normally beneficial, sometimes injure strawberries?
6. Name three insects of importance which attack raspberries and blackberries; give life history and remedies for each.
7. Give life history and remedies for the imported currant worm.
8. What difficulties are met in combating the four-lined leaf-bug?
9. What striking feature indicates the presence in injurious numbers of the currant plant louse? What is the reason for this?

10. Describe the work and methods of control of the currant fruit fly and the gooseberry fruit worm.
11. Give description, life history, and remedies for the grape root worm.
12. What new and interesting facts have been brought to light in connection with the rose chafer?
13. Compare the work of the grape-vine phylloxera in Europe and America.
14. Discuss the grape-vine leaf-hoppers.
15. Name three other insects not referred to above which you regard as injurious to the grape.
16. Mention four of the most injurious cranberry insects and give remedial measures therefor.

CHAPTER XI

PRINCIPAL INSECTS AFFECTING CITRUS FRUITS

PROBABLY the worst pests with which orange and lemon growers have to contend are the various scales found on branches, trunks, twigs, and leaves, and in some instances on the fruit itself. But a number of other insects attacking citrus fruits are discussed in this chapter.

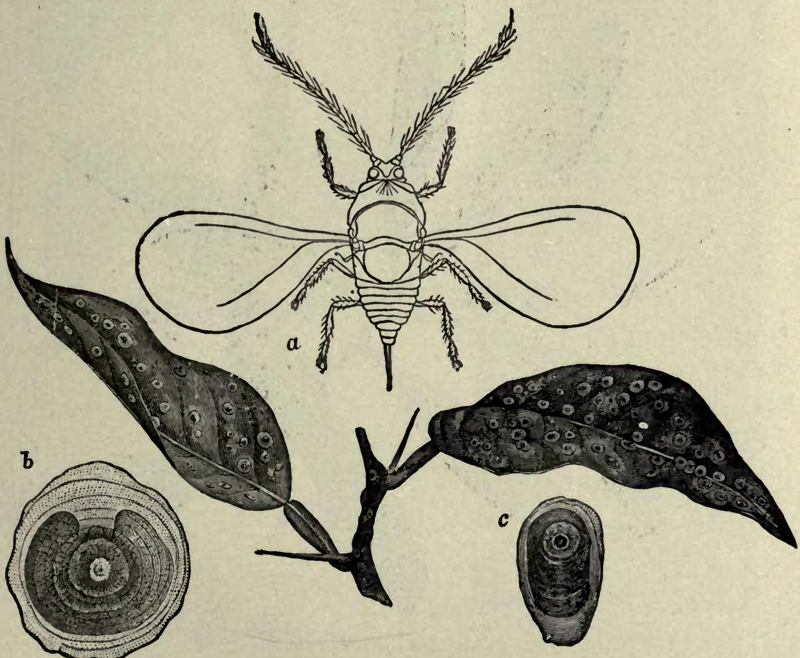


FIG. 190.—The red scale: *a*, winged male; *b*, female scale; *c*, male scale.

Scale Insects.—Among the scale insects may be mentioned the following: (1) The red or orange scale (*Chrysomphalus aurantica*) (Fig. 190).

(2) Yellow scale (*C. aurantica* var. *citrinus*).

(3) The black scale (*Saissetia oleæ*) (Fig. 191), indirectly the cause of black fungous growth on the tree.

(4) The soft orange scale or broad scale (*Coccus hesperidum*) (Fig. 192), everywhere very common.

(5) The cottony cushion scale or ribbed scale (*Icerya purchasi*) (Fig. 193), one of the pests of citrus fruits, but now held fairly well in check by predaceous insects introduced from Australia.

(6) The purple scale (*Lepidosaphes beckii*) (Fig. 194).

(7) The long scale (*Mytilaspis gloveri*) (Fig. 195).

FIG. 191.—Black scale.

(8) In addition, growers have to contend with the circular scale (*Aspidiotus ficus*) (Fig. 196).

(9) The greedy scale (*A. rapax*) (Fig. 197).

(10) The white scale (*A. nerii*). There are also two or more troublesome varieties of mealy bugs (*Pseudococcus* sp.) (Fig. 198).

Space hardly allows a detailed description of all of the above. They all yield to the same general treatment. Briefly, it may be said that under the chitinous covering referred to as a "scale"

the insect is found; the female produces either living young or eggs, and the young scales crawl about for a time before becoming permanently located, after which they secrete their own covering scale.

This group is subject to the attack of many parasites and predaceous insects. Among the latter, "lady beetles" or "lady birds"

FIG. 192.—The broad scale.

FIG. 193.—Cottony cushion scale on orange twig. (Quayle, Cal. Bull., 214.)

are the most prominent and the most useful. Any effort to eradicate scale insects must naturally result also in the death of many beneficial forms preying upon them. But, inasmuch as citrus growers cannot depend upon the services of the latter, radical treatment must be resorted to.

Remedies for Scale Insects.—*Spraying* has been largely superseded by fumigation, but is still in use in many orchards. For citrus trees, kerosene emulsion is probably the safest of the various

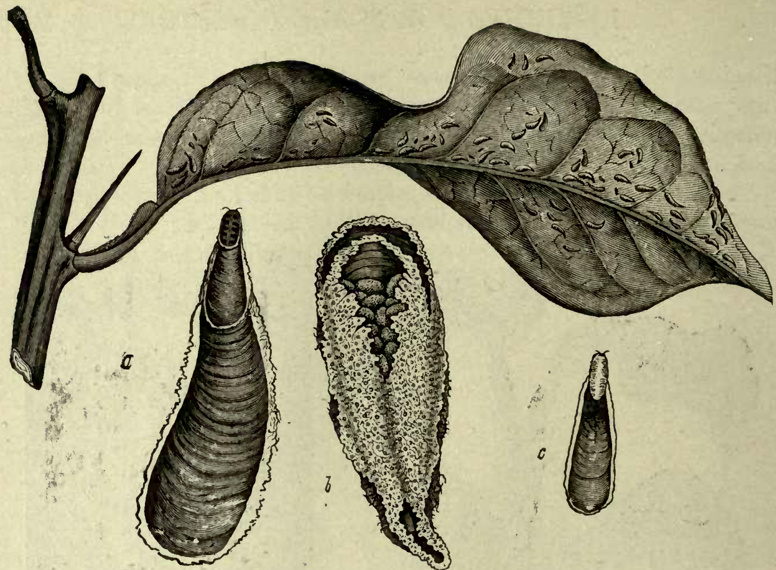


Fig. 194.—Purple scale; *a*, female scale, dorsal view; *b*, ventral view; *c*, male scale.

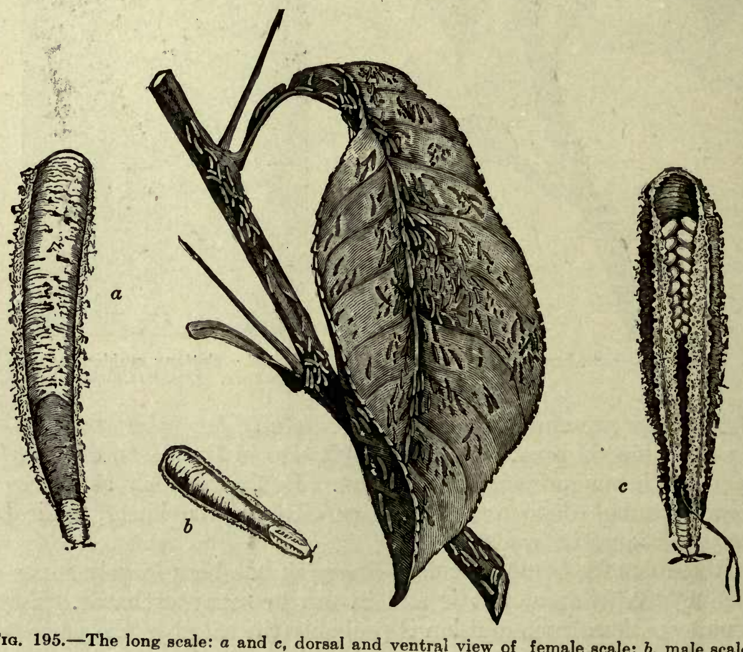


Fig. 195.—The long scale: *a* and *c*, dorsal and ventral view of female scale; *b*, male scale.

compounds. This is made by dissolving one-half pound soap in one gallon of water by boiling. Remove from fire and add one gallon of cheap kerosene. Churn by forcing through spray pump and add fourteen gallons of water, mixing thoroughly. It should be used at once. This spray is intended to be employed when young scales are crawling over the trees.

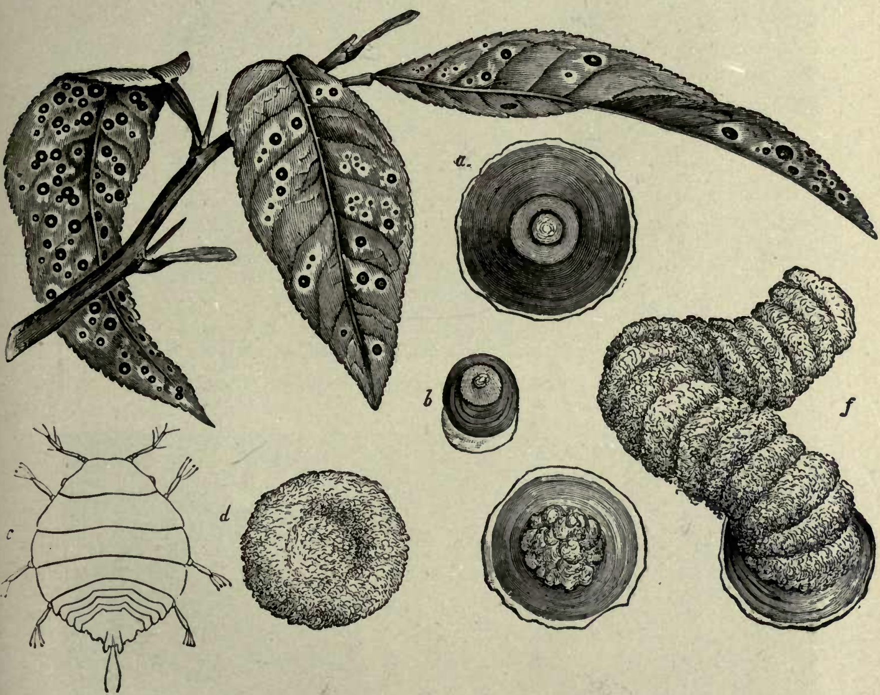


FIG. 196.—The circular scale.

Fumigation is, on the whole, more satisfactory than spraying and is in more general use in citrus orchards. The chemicals most commonly employed are cyanide of potash and sulfuric acid. The most desirable proportions are one ounce of cyanide of potash to two fluid ounces of commercial acid and four fluid ounces of water. Canvas tents made of eight-ounce canvas should be used to cover the trees. These may be rendered more impervious to gas leakage by painting thoroughly with boiled linseed oil, or in other ways.

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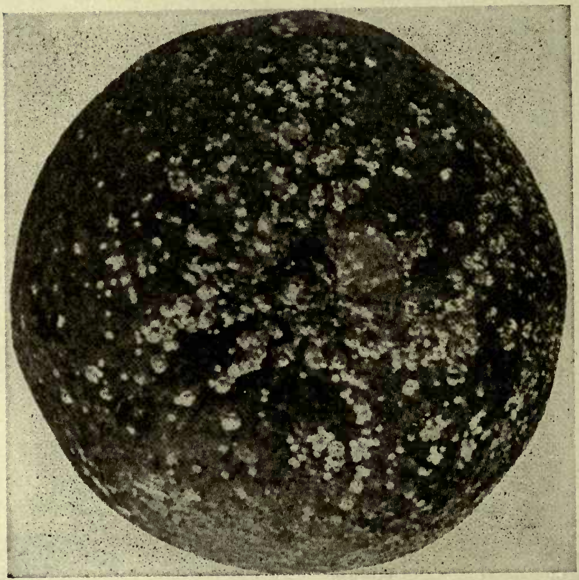

FIG. 197.—Orange infested with greedy scale. (Quayle, Cal. Bull., 214.)

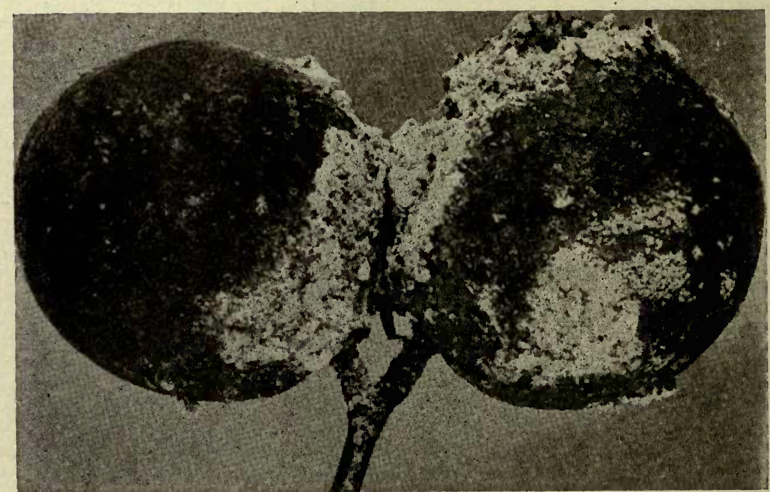

FIG. 198.—Mealy bugs on orange. (Quayle, Cal. Bull., 214.)

The tents are constructed on various plans, according to the preference of the grower.

Manifestly some standard of dosage must be followed to secure the desired results with safety, and the necessary charges have been well worked out by entomologists. A formula is obtained by multiplying the circumference of the tented tree by the distance over the top. Point off two places in the result. For example: a tented tree measuring twenty feet around and thirty feet over would require six ounces of cyanide of potash for the purple scale. Using the proportions given above, the formula would be: six ounces cyanide, twelve fluid ounces acid, and eighteen fluid ounces

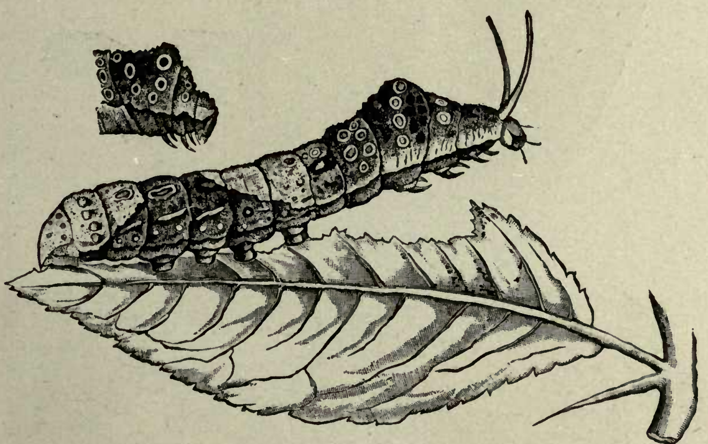

Fig. 199.—Larva of cresphontes butterfly.

water for each tree. This, however, is for the purple scale only. For the red, yellow, and black scales the amount should be reduced about one-quarter. Since different methods of fumigation are practiced in different sections and different dosages are required for various scales, growers are advised to consult with their own experiment station authorities in undertaking this work for the first time. For remedies for the San José scale see page 72.

"The Orange Dog," or Cresphontes Butterfly (*Papilio cresphontes* Fab.).—This conspicuous caterpillar, which feeds in the North on prickly ash and other plants, is at times a serious enemy to the orange, stripping the leaves from young trees.

Description and Life History.—When full grown the larva is

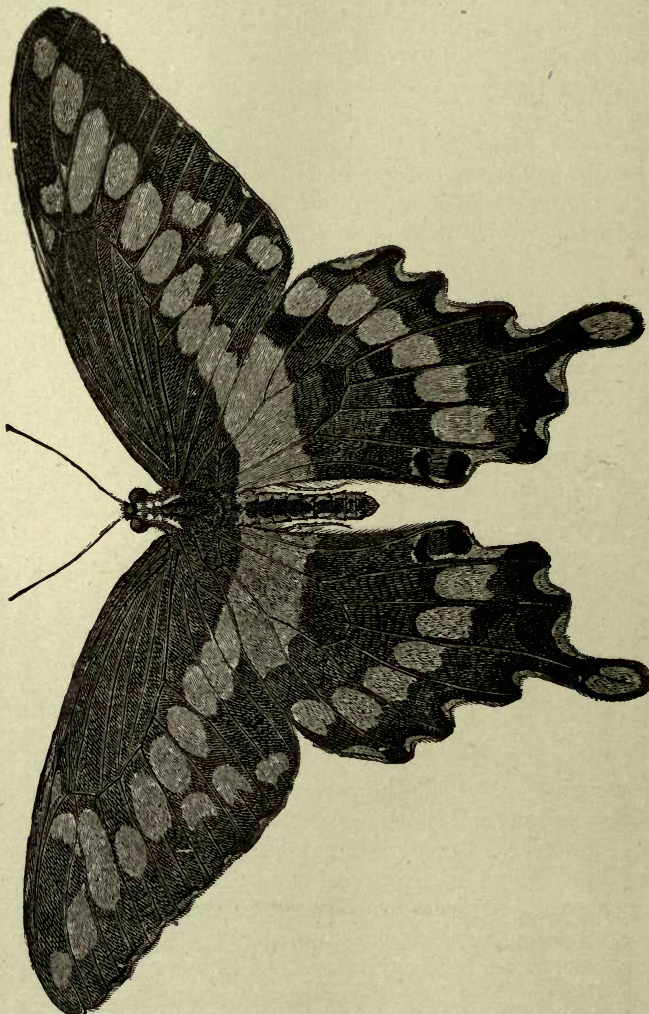

Fig. 200.—Cresphontes butterfly.

about two inches long, dark brown, and marked with white or light areas spotted with brown. Between the fourth and fifth segments is a large white patch, and a more or less similar patch is found upon the posterior end of the larva. The most striking feature of the caterpillar consists of two long "horns," flesh colored, just behind the head, which may be extended, and which exude a bad-smelling fluid (Fig. 199).

FIG. 201.—Work of thrips (*Euthrips citri*) on oranges. (Quayle, Cal. Bull., 214.)

When the caterpillar is about a month old it forms a grayish or brownish chrysalis; is fastened to a twig by means of an attachment at the lower posterior end and by a silken thread which passes around the twig and around the middle of the insect.

The butterfly (Fig. 200) is one of our most striking insects, its wings measuring nearly five inches across. The black ground color of the upper surface is marked by spots and bands of yellow.

Below, the wings are yellow, with blue spots on the hind pair.

Control.—Hand-pick the caterpillars and pupæ.

Orange Aphis.—This is a black or brownish aphid (*Siphonophora* sp.) with yellowish legs. It sucks the sap from the twigs of the orange. Both winged and wingless forms may be seen on the trees at the same time, the winged form migrating to other trees. The life history of the orange aphis agrees in general with that of other aphids.

Control.—A spray of strong soapsuds or tobacco extract, with soap added, is generally sufficient to control this pest. It is attacked by predaceous and parasitic insects.

Orange Thrips.—Of the various species of thrips which work on the orange, this (*Euthrips citri* Moul.) appears to be the most injurious, for if it does not render the fruit unmarketable (Fig. 201), it at least obliges grocers to classify it as an inferior grade. In certain regions in California it is proving an injurious pest. Various species of thrips may be observed about the blossoms of orange trees. They are blackish or yellowish insects which move rapidly.

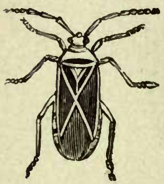

Fig. 202.—The cotton stainer.

Control.—Spraying is the most effective method of controlling these insects, and the following is recommended by the United States Bureau of Entomology:

Commercial lime sulfur, 2½ gallons; black leaf extract, 2 gallons of 2¾ per cent or 14 fluid ounces of 40 per cent; water, 200 gallons.

Possibly three applications may be necessary at intervals of about ten days. The spray should be applied forcibly.

The Rust Mite.—The rust often observed on the fruit of the orange is caused by the activities of a whitish mite (*Phytoptus* sp.) which is frequently found in large numbers on the skin.

Control.—A strong soap solution is recommended for the extermination of this pest.

The Cotton Stainer (*Dysdercus suturellus* H. Schif.).—This bug is not only a bad pest of cotton, but it also sometimes seriously injures the fruit of the orange by sucking the juice. As a result of its work the fruit may decay and fall. When adult (Fig. 202) its ground color is black, with red anterior markings. The margins of the body are pale yellow, and two white lines cross on the back when the wings are folded. It is bright red below. The eggs are

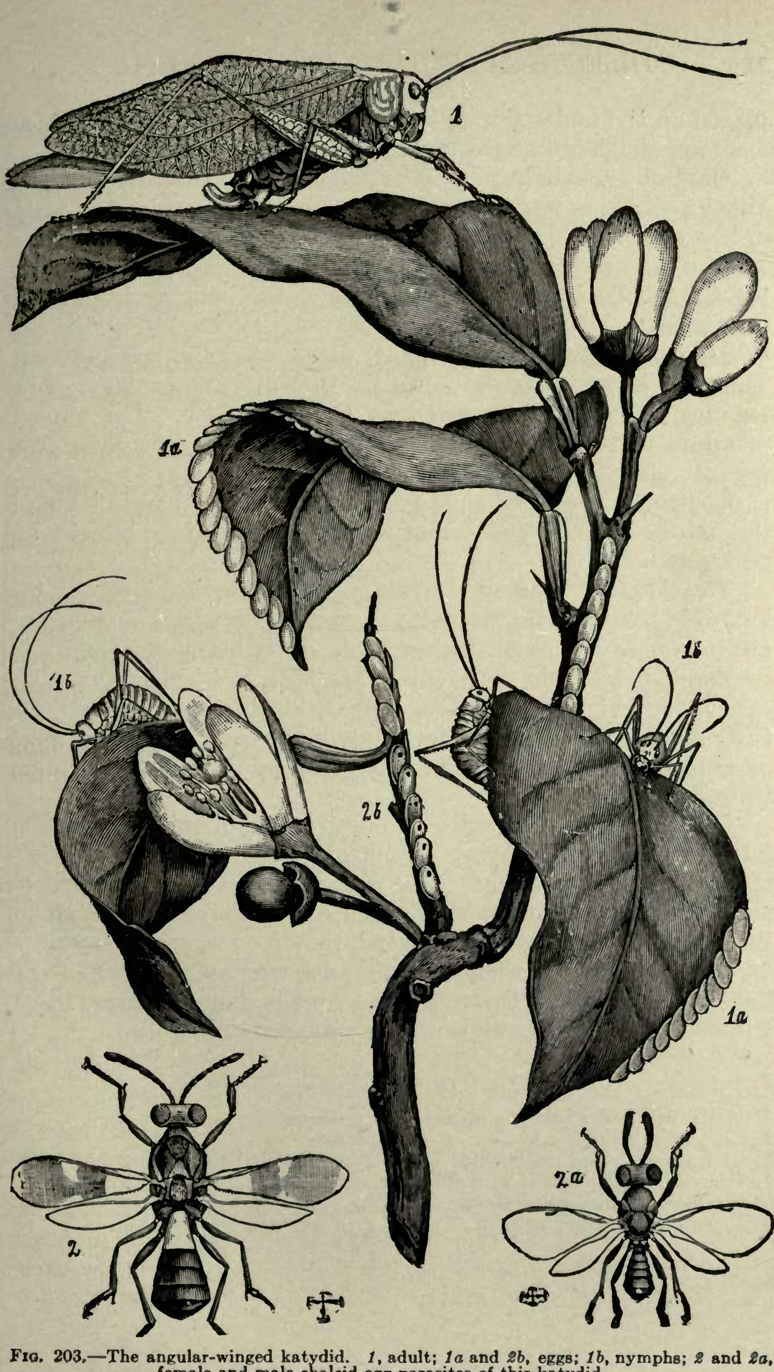

FIG. 203.—The angular-winged katydid. *1*, adult; *1a* and *2b*, eggs; *1b*, nymphs; *2* and *2a*, female and male chalcid egg-parasites of this katydid.

placed on the under side of leaves. The nymphs emerging therefrom are strikingly bright red with dark legs.

Control.—These bugs are attracted to cotton seed and may be killed by making use of small piles of seed and pouring hot water or kerosene upon the bugs when gathered together.

The Orange Basket Worm.—The male insect is dark brown, the female whitish. Eggs are laid in a case hanging from a leaf or twig made by a larva when full grown. Before mating, the case is dragged about by the occupant, whose head and legs protrude. This case is evidently made up by bits of bark or leaves held together by a thread secreted by the caterpillar. The pupa is found in the suspended case, the male pupal skin protruding from the case after the perfect insect has issued.

Control.—These cases are so conspicuous that hand-picking is the most obvious method of control where the insects are discovered.

The Angular Winged Katydid.—A night-loving insect is this katydid (*Microcentrum retinervis* Burm.). It is green in color and about two and one-half inches long. It is better known by its rasping note heard in the evening than by any other feature. The eggs are laid in such a way that they overlap on both leaf and twig (Fig. 203). This insect is fortunately attacked in the egg stage by an abundance of parasites and as an adult it is preyed upon by birds.

Control.—Winter pruning and destruction of cuttings are helpful. Instead of destroying all cuttings, enterprising orchardists often collect eggs in winter and place them in boxes covered by fine wire gauze. If the young hatch, they are destroyed. But if the egg parasites issue in the spring, they are allowed to escape.

The Lubber Grasshopper (*Romalea microptera* Serv.).—This huge, slow-moving Orthopteran occasionally damages citrus fruits. It does not fly and consequently can be easily controlled.

QUESTIONS

1. Name five scales injuring oranges and lemons.
2. Give briefly the life history of scale insects.
3. Tell what class of insecticides is called for in their treatment.
4. Describe fumigation of orchard trees for scale insects.
5. Mention several other insects attacking citrus fruits.
6. Describe the injury of each of these; give methods of control for each.

CHAPTER XII

INSECTS AFFECTING FIELD CROPS AND PASTURAGE

The enormous amount of grain and other field crops raised in this country, and the importance of stock-raising and milk production, are such as to make consideration of insects affecting field crops and pasturage of special importance. The pests concerned are discussed in the following pages.

WHEAT INSECTS

Hessian Fly (*Mayetiola destructor* Say).—This fly, which causes an annual loss of many thousands of dollars in the United States, is hardly ever observed by the layman on account of its extremely small size. It is a dark-colored gnat with two wings. As it is only one-tenth of an inch long (Fig. 204), probably not one in a thousand of our farmers has ever seen this insect in the adult stage.

Life History.—The so-called "flaxseeds" (Fig. 205) which represent the pupal stage are easily observed under the sheathing leaves, next to the stem, generally above the first joint, although they may be found higher up on the stem. The fly emerges from these flaxseeds either in the stubble or in the grass or weeds along the edges of the fields. It lays from one hundred to one hundred and fifty eggs in early spring on young wheat plants.

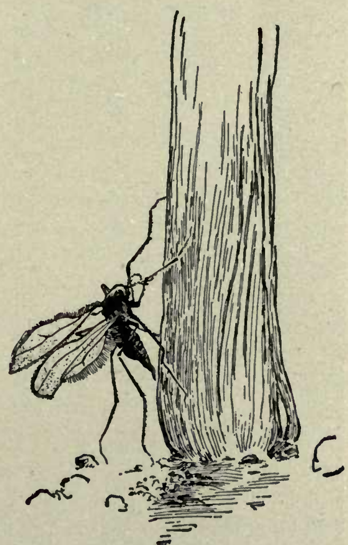

Fig. 204.—Hessian fly on wheat plant, much enlarged.

The maggots hatching from these eggs work against the stem beneath the sheath leaf as above indicated. The winter is passed in the pupal stage; called "flaxseed" because of its resemblance to the seed of the flax plant.

Injury.—Affected plants, when young, appear darker than

normal plants. Later, when the head is formed and about the time the grain is in the milk, the weakened straw breaks just above the working place of the maggot, causing the grain to lodge or

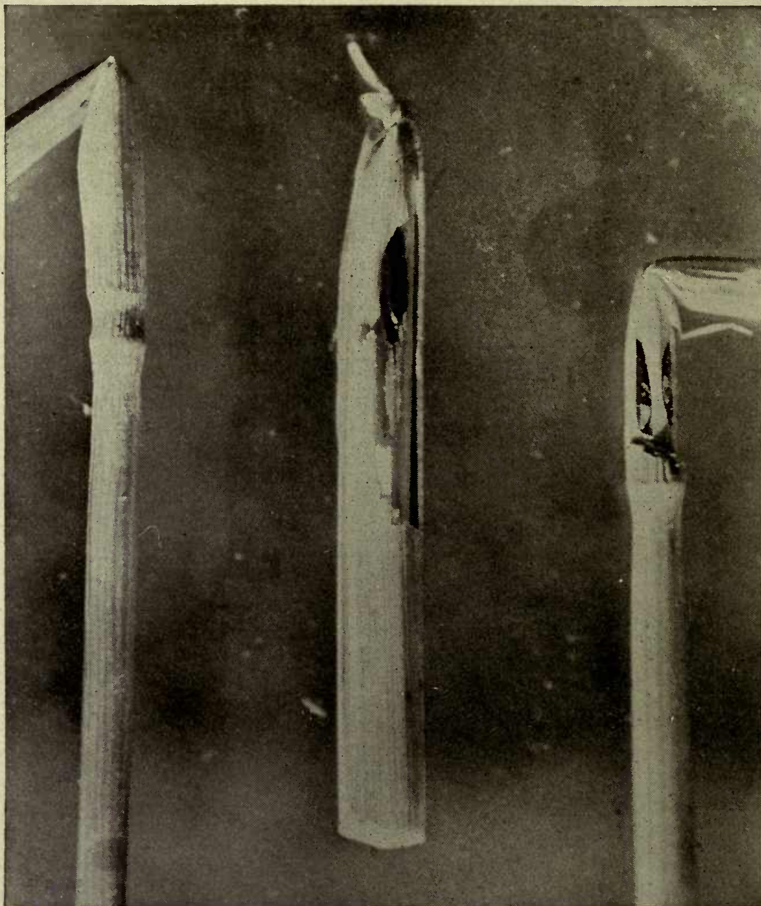

Fig. 205.—Puparia of Hessian fly, so-called "flaxseeds," in infested wheat stems. Also showing characteristic breaking down of stem. (Original.)

the heads to lie on the ground and be missed by the binder. Kernels in affected plants are poorly filled and shrunken.

Control.—Plowing the stubble and rotation of crops are good farm practices in connection with this insect. All volunteer

wheat or other small grain, as well as grass growing around the edges of the fields, should be destroyed. Varieties of wheat with coarse, strong stems are less liable to injury. Field wheat should be sown as late as possible. Burning the stubble where practicable will destroy the flaxseeds. A good system of plowing, crop rotation, and modern methods of agriculture, however, are the best methods of prevention.

The Wheat Stem Maggot (*Meromyza americana* Fitch).—Unlike the Hessian fly, the larva of this two-winged insect feeds *inside* the stem, causing it to become discolored or to die. Sometimes the stem is cut off entirely. The adult fly is one-fifth of an inch long, of a general yellowish-white color, with three black stripes on the thorax and abdomen. The eyes are bright green. The larva or maggot is light green in color, one-fourth of an inch long, tapering toward either end. The adults lay eggs at intervals during the summer. The winter is passed by the larvæ in young plants, where they transform into pupæ. This insect also attacks rye (Fig. 206).

Control Measures.—Since this insect feeds and breeds also in wild grasses, it is difficult to control. Where possible and safe, it is suggested that the stubble be burned over. Fall-plowing, clean cultivating, and rotation of crops are the most desirable measures of prevention.

The English Grain Louse.—Only in latitudes where the winters are comparatively mild will grain plant lice (*Macrosiphum granaria* Buckton) seriously injure crops. They are found on wheat, rye, and other winter grains. They feed on the leaves when young and later gather on the ripening kernels in the heads, injuring the yield and quality of the grain very seriously.

The life history is approximately the same as for other plant lice. There are both winged and wingless forms. Each female gives birth during the summer to forty or fifty young, the same reaching maturity in about twelve days. When there is need of migration, winged forms appear. As many as fourteen generations have been observed in one summer in the latitude of Minnesota. These lice are yellowish green. The two honey tubes projecting from the back of each insect are quite long and black in color.

Control.—Parasites and other natural enemies generally hold this pest in check. No practical remedy is known and none needed in most latitudes. Clean farming and rotation of crops are recommended.

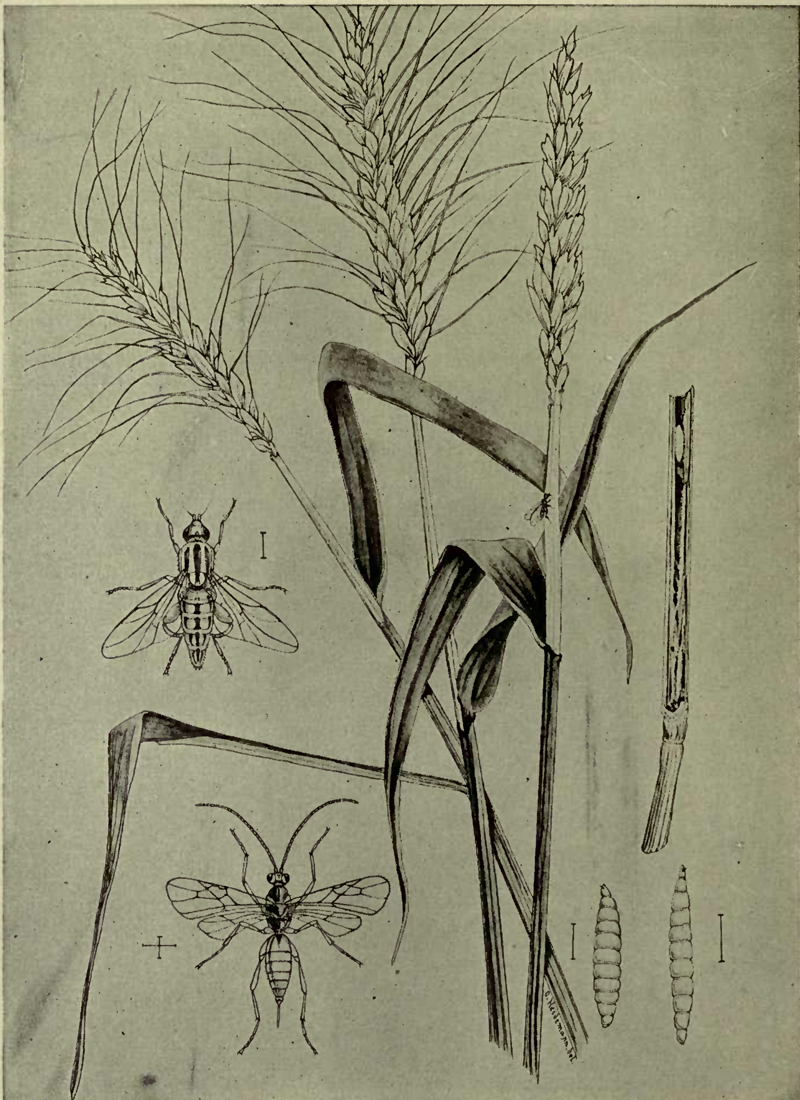

FIG. 206.—Wheat stem maggot; three infested stems, full-grown larvæ, and parasite. Hair lines indicate natural size in each case. (Lugger.)

The "Green Bug."—The spring grain aphis (*Toxoptera graminum* Rond.) has of late years caused much injury to grain in Kansas, Oklahoma, Texas, and a few other states where the winter weather is such as to check the growth of parasites which normally keep this pest within bounds, and yet allows the continuous breeding of the louse. Figure 207 gives a good idea of the appearance of this aphid. Winged forms (Fig. 208) are carried northward by the wind, but in northern states it does practically no damage.

Control.—No measures of control are necessary in the northern states where cold winters are the rule. In the South no volunteer grain should be allowed to grow; all such growth should be destroyed in the early fall.

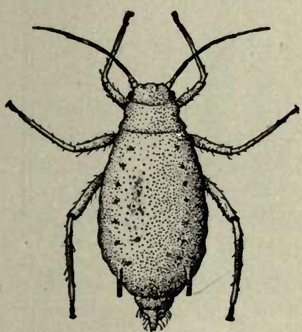

Fig. 207.—The "green bug" (*Toxoptera graminum*).

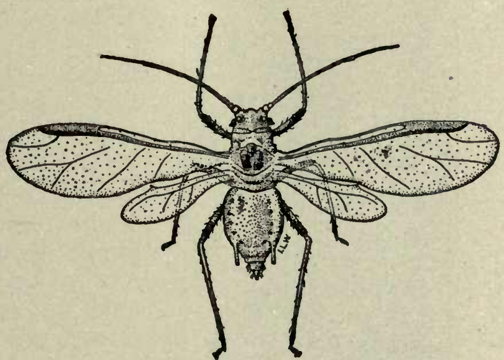

Fig. 208.—The "green bug," winged migrant form.

The Frit-fly (*Oscinis* sp.).—This fly (Fig. 209) looks very much like a small house fly. The tiny white eggs are laid in the fall on fall-sown wheat or other grain. The larvæ pass the winter within the plant. In regions where spring-sown grain is the rule, the insects hibernate in the larval stage in the straw and stubble. The adults emerge in spring and lay eggs which produce the first brood of maggots. Another brood of flies emerge during midsummer in regions where fall-sown grain is grown, laying eggs on volunteer grain plants and various grasses, the next brood of flies—the fall brood—laying their eggs on the young plants of the fall-sown field.

Injury.—Heads of wheat and other grains sometimes wither and die or are filled with shrunken kernels as a result of the work of this insect. Sometimes the stem is cut off by the young maggot within. The presence of the pest is indicated by a premature

yellowing of the head and of the stalk above the infested point, generally three or four inches above the ground. This is followed by a breaking down of the plant. Just below the point of breaking the maggot can generally be found within the stem.

Control.—If straw is stacked, many hibernating insects will not be able to reach the surface of the stack. Burning or feeding up the straw will, of course, destroy all wintering forms. In regions of spring-sown wheat, burning the stubble in the fall, where possible, is a good remedial measure, as is also the plowing under of stubble. The latter method is the most practical in the northern states.

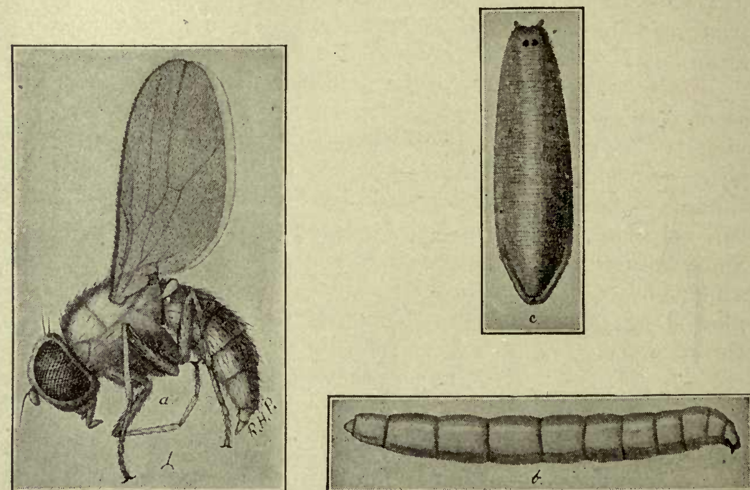

Fig. 209.—The frit-fly: *a*, imago; *b*, larva or maggot; *c*, puparium containing the pupa. All much enlarged. (After Lugger.)

The Wheat-head Army Worm (*Meliana albilinea* Hbn.).—This is one of the cut-worm moths. The female lays her eggs on leaves of different grains, timothy and other grasses. The worms are observed at work in June and July and have been found entering the pupal stage in the middle of the latter month.

Injury.—Timothy sometimes suffers seriously. Four-fifths of the timothy seed crop has been known to be destroyed during one season, and the hay crop seriously injured. On wheat the worms eat the kernels of the grain, allowing the chaff to fall to the ground (Fig. 210).

Description.—The adult moth is brownish yellow, resembling in a general way other cut-worm moths. The caterpillars or larvæ vary in color from green to very dark brown or blackish; they almost invariably show characteristic stripes on back and sides. When full grown, they are one and one-fourth inches long. The pupæ are of mahogany color; three-fourths of an inch long. They are found two or three inches in the ground.

Control Measures.—Some of the following methods are applicable to pastures when attacked, and some to grain:

Early fall pasturing will starve the second brood. Wild grasses in the vicinity of cultivated crops should be destroyed. Plow stubble early in the fall. Land should not lie in pasture for more than three or four years. Since these worms sometimes march to a field in a vast army, furrows can be plowed across this line of march, throwing the furrow away from the crop to be protected. The worms may be killed in the furrows with kerosene or by covering them with straw and burning it. Where practicable, a strip of grain or pasturage across the line of march should be sprayed with a strong solution of Paris green, or, better, with arsenate of lead.

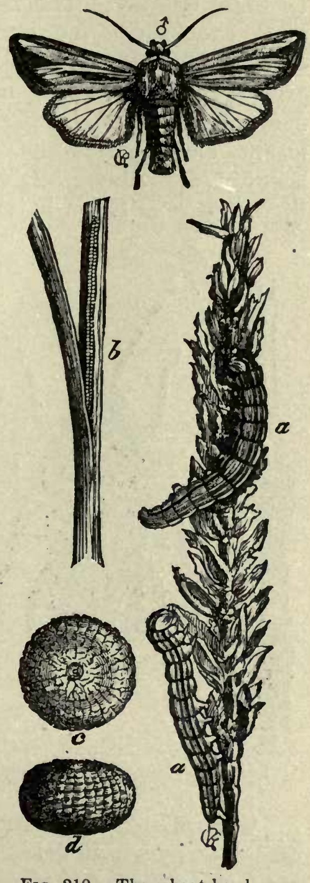

Fig. 210.—The wheat-head army worm: *a*, *a*, worms feeding on head of grain; *b*, eggs under a leaf sheath; *c*, *d*, two views of eggs, enlarged; the male moth. (After Riley.)

The Chinch Bug (*Blissus leucopterus* Say).—This vile-smelling bug is well known to most of our farmers and owes its names to its bedbug odor, its name being a corruption of a Spanish word meaning bedbug. The adult is one-fifth of an inch long. It has a black body and white wings, each marked with a black triangle on the outer margin. The bases of feelers or antennæ and bases

of the legs are reddish. The young bugs are yellowish or bright red, marked with brownish black. They grow darker with age.

Life History.—This insect passes the winter in the adult stage under shocks of corn or under leaves in the woods or under rubbish of any sort in the fields. It comes out as soon as warm weather arrives in the spring, generally early in May, and flies to wheat, rye, barley, or grass lands. Here the female deposits eggs upon the ground close to the roots of the plants or upon the bases and roots themselves. About 500 eggs are laid during a period of ten to fifteen days. These hatch in two weeks, the nymphs beginning at once to feed like the adults by sucking the juices from the young plants. There are generally two broods. Since, however, the eggs laid by one female are not all deposited at once, in the latter part of the summer insects of all stages are observed. From fifty-seven to sixty days are required for the life cycle of one generation.

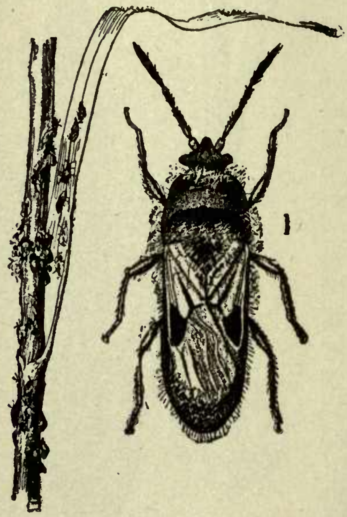

Fig. 211.—Diseased chinch bug. (Lugger.)

Injury. — Although grains and grasses are weakened by attack, the worst injury occurs upon corn, for corn is sought after the grasses or grains ripen. Frequently one observes in the field a vast army of chinch bugs of all ages migrating from grain field to corn field, appearing to know instinctively the direction in which their chosen food lies.

Control.—We have not as yet learned to successfully control this pest in wheat fields, and all our efforts are directed against protecting the outer rows of corn. While the Hessian fly prefers the moist weather, rains destroy young chinch bugs and encourage the growth of parasitic fungi (Fig. 211). Unlike the Hessian fly, therefore, the chinch bug prefers and revels in the hot sun. It is a frequent practice to interpose some barrier between the advancing bugs and the corn fields. A deep furrow with the steep side toward the corn may be plowed if the bugs are observed in time. The insects which gather in the furrow may be destroyed with kerosene

or burned with straw. A band of tar road oil three inches wide may take the place of the furrow. In irrigated regions a water barrier is effective. Some states have found burning the bugs in their winter quarters to be extremely helpful; and this may protect the wheat fields. Spraying the outer rows of corn with nicotine sulfate has also been practiced.

It has been observed that in chinch-bug years farmers who allow pigeon grass and other so-called weeds to grow among the corn have not suffered from the attacks of chinch bugs as much as the more careful farmers. Careless farming is not to be encouraged, but it may be suggested that in cultivating corn in chinch-bug

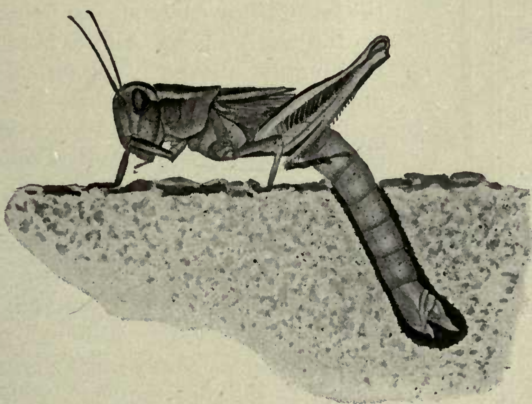

FIG. 212.—A grasshopper ovipositing. (After Howard.)

years the three or four outer rows be left uncultivated in order that the weeds may have a chance to grow and protect the balance of the corn crop.

Grasshoppers.—It is hardly desirable to describe the various species of grasshoppers in a work of this kind. All of our related grasshoppers have approximately the same life history. They are really locusts belonging to the family Acrididæ, not grasshoppers. The winter is passed in the egg stage, the young hatch in spring. The wingless young are rather inactive and clumsy until after the second or third moult. If food is scarce at this time, they congregate in great numbers and march across country, devouring every green thing in their path. Often fields and forests are deprived of every bit of foliage.

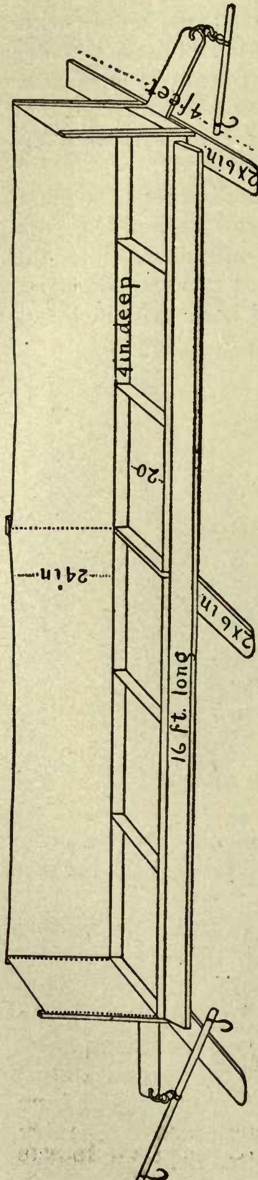

Fig. 213.—Details of construction of hopperdozer. The back and sides are canvas. (Original.)

These insects are essentially single-brooded. Figure 212 illustrates a female, with badly frayed wings, egg-laying.

Natural Enemies.—They are at all times subject to the attacks of birds, skunks and many other animals, and the eggs are eaten by two or more species of blister beetles, as well as ground beetles, harvest mites, etc. Fungous and bacterial diseases also play a large part in reducing their numbers.

Control Measures.—Deep plowing in the late fall or early spring helps to break up the egg masses. Alfalfa land should be thoroughly disked. When the young appear in the spring, it is sometimes possible to burn the stubble. Bunches of straw may be scattered about on cold days and the grasshoppers gathering thereon may be burned. Farmers sometimes destroy the newly hatched "hoppers" when occurring in grass land or a field in any crop by plowing, beginning at the outside and working into the center of the field. Many are buried in the furrows. Ditches two feet wide and two feet deep may form impassable barriers in the line of their march. If there is water in the ditches, the surface should be oiled. Before grasshoppers become winged, hopperdozers are used effectively. Figure 213 illustrates details of structure of a hopperdozer. See also figures 70 and 71. Flocks of turkeys in the field do much to reduce the numbers of this pest. Coöperation among farmers when the grasshoppers first appear is not only desirable but very necessary.

A poison spray, quite successfully used, is made as follows: Arsenite of soda, 3 pounds; molasses, 1½ gallons; water, 180

gallons. Fifty gallons of this is sprayed over an acre. The material costs about thirty to fifty cents per acre. Insects partaking of this poison appear to be paralyzed and die in from twelve to thirty-six hours. No injurious effects are noticed among animals eating foliage thus sprayed (Fig. 214).

Poisoned bran mash may also be scattered about where cattle and chickens have not access to it. It is found useful in portions of the West and South. It is made as follows: two pounds Paris green, twenty-five pounds bran, two gallons cheap molasses. Mix

FIG. 214.—Spraying for grasshoppers.

the Paris green with the dry bran, moisten with water, and stir in the molasses. This mixture should be about the consistency of chicken feed and should be broadcasted over infested fields in the evening or early in the morning, before sunrise. The United States Department of Agriculture recommends the following as an effective bait: Mix one pound Paris green with twenty-five pounds of wheat bran. To two quarts of cheap molasses or syrup add the juice of two oranges or lemons, as well as the finely chopped skin and pulp of the fruit; dilute this with two gallons of water and add it to the poisoned bran. Add enough more water to make a stiff dough. This is to be spread as above indicated.

Joint Worms.—The different species of this group, *Isosoma*, are four-winged flies. They live through the winter as larvæ or pupæ in cells in the stem of wheat and some other grains. The adults emerge in spring after the young grain has thrown up stems so that several joints have become exposed. The female places her eggs in these stems and the larvæ feed within, becoming full grown by the time the straw is hardened. They pass the winter in the cells thus made.

Injury.—This is a serious pest in the wheat regions west of the Mississippi River. The damage varies from being slight to a total loss of the entire crop. Swellings and other malformations arising from the presence of this insect often occur in infested straw. Such straw is brittle and woody. By cutting off the sap supply from the head, worms prevent the filling out of the kernels. The wind also breaks down these brittle straws. At threshing time its presence is shown by hard bits of straw containing larvæ appearing in the threshed grain.

Control.—The following suggestions are not always applicable; a farmer must select such as are practicable for the circumstances existing on his farm: Fields should be worked into the best possible condition before seeding. Sow as early as possible, and use early-maturing varieties. Fields should be well fertilized, thus inducing rapid and vigorous growth. Practice rotation of crops. Plow under or burn stubble in late fall. Burn all infested straw which has not been fed or used by the last of April.

INSECTS ATTACKING CLOVER AND ALFALFA

The Clover-seed Chalcid.—This tiny, four-winged fly (*Bruco-phagus funebris* How.) is sometimes erroneously referred to as a "weevil" by farmers. It deposits its eggs in the young seeds. This gives rise to a tiny grub, which devours the entire contents of the seed. It may also enter larger seeds. It transforms from the larval form to the pupal form within the seed (Fig. 215).

Injury.—This insect has been so destructive in places that the raising of clover for seed has been abandoned. In clover-raising sections of Minnesota the depredations of this insect cause an annual loss of many thousands of dollars. The clover itself is not injured by its work. Affected seeds are more or less misshapen or undersized and can, for the most part, be detected in the mass of seed offered for sale.

Control.—Cut the hay crop while heads are still green to prevent the maturing of the pest and the consequent attack on the

seed crop. As is very evident, coöperation among farmers in the neighborhood is very necessary. These recommendations apply to medium red clover, not to mammoth clover, since in this variety the first cutting is utilized for seed. One should also cut all volunteer red clover along roadsides and fences, and all waste about the huller should be swept up and destroyed, since many of the infested seeds are separated out by the huller.

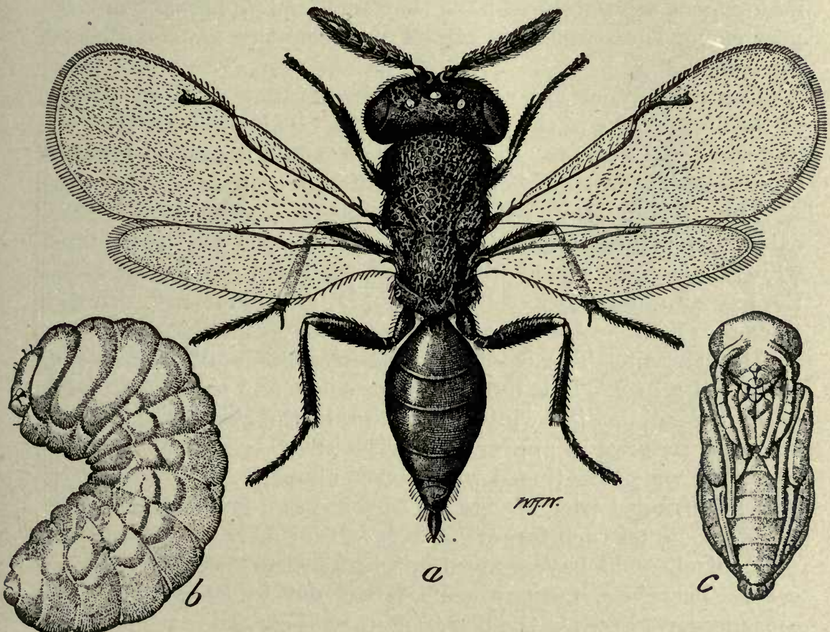

FIG. 215.—Alfalfa-seed or clover-seed chalcis fly: *a*, adult; *b*, larva; *c*, pupa. Much enlarged. (Urbahns, U. S. Bu. Ent.)

The Clover Root-borer.—The adult insect is a reddish-brown beetle (*Hylastinus obscurus* Marsh) about one-eighth of an inch long. These insects hibernate in the clover roots, beginning their work in the roots when warm weather begins. Eggs are deposited along the sides of the burrow in the spring. Frequently, however, they are laid on the crown of the plant and sometimes even at the sides of roots two or three inches below the ground. Frequently the larvæ feed in the excavation made by the mother, but soon start burrows on their own account. By the middle of summer

most of them have become full grown and pass into the pupal stage. The second brood of beetles appears in the fall, not leaving the plant, however, until the following spring. The dispersal of these insects takes place in spring; the beetles then fly about seeking uninfested plants.

Injury.—The tap roots of Mammoth and Common Red Clover are sometimes seriously injured by this insect, while alsike is not so subject to attack. Since alfalfa in Europe has been injured, we may expect ultimately to have the same trouble here. The first-year clover is exempt from attack on account of the small size of the roots.

Control.—Wherever possible, summer fallow the soil as soon as the first cutting of the crop is removed. This dries out the roots and starves the larvæ. Fields of clover should not stand in clover more than three years. Scientific rotation of crops is also desirable.

The Clover Hay Worm (*Hypospygia costalis* Fab.).—This caterpillar attacks hay in the stack. It interweaves the hay with white silken webs mixed with black particles of excrement, giving the hay an appearance of being mouldy, and reducing much of it to chaff. Such hay is not attractive to stock.

Description.—The caterpillar is three-fourths of an inch long when full grown. It is dull brown in color, and may be found in barns throughout the winter, pupating in the spring. The moth is rather striking in appearance, with wing expanse of one inch. The silky wings are tinged with purple above, margined with yellow, and fringed with orange. There are two large, conspicuous, golden spots on each fore-wing.

Control.—Old hay is more apt to be attacked than the new crop. Therefore, farmers are advised not to keep hay over a second year. Feeding the hay to stock will cause the young caterpillars in infested hay to perish before the new crop comes in. Hay-mows should be cleaned out each spring, and one should never place new hay on top of the old. It is suggested, further, that new stacks of hay be built at some distance from the old. All refuse from old stacks or the bottom of the hay-mow should be burned. Stacks should be raised above the ground on a foundation of logs or rails so that the bottom may be kept fairly cool and dry. These caterpillars are more active where there is warmth and moisture. It is further suggested that hay be salted on the bottom of the stack or mow, using about two quarts of salt to every ton of hay.

Blister Beetles (*Macrobasis unicolor* Kby. and *Epicauta penn-*

sylvanica DeG.).—The first named of these beetles is grayish in color, and the second shining black. These beetles are striking in appearance, have rather long legs, with a somewhat elongated thorax or neck (Fig. 216). The bodies are long, straight-cut, and are said to cause blisters when crushed on the skin. A near relative found in Europe is known as the "Spanish fly" and is used in medicine. The adult beetle emerges in the spring.

Injury.—Occasionally these beetles are extremely injurious to leguminous plants, although they may be regarded as general feeders. They work also on sugar beets, potatoes, various flowering plants, and trees and shrubs.

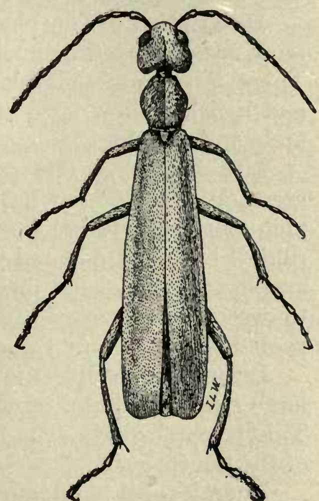

Fig. 216.—A blister beetle.

Benefit.—These insects have the redeeming feature that when hatched the small, long-legged larvæ immediately run about searching for grasshopper eggs in the field. Upon these they feed. A little later the skin of the larva is shed, together with the long legs of the first form of larva, and we find them in the second stage possessing very short rudimentary legs. This form is found in grasshopper nests feeding upon the eggs.

Control.—These beetles are quite resistant to arsenicals, but can be driven off of a crop by applying Paris green or arsenate of lead sprays. When occurring on trees, they may be jarred off on sheets and destroyed by being thrown into kerosene. This same method may perhaps apply in the case of some other plants if the attack is not too general. The usual arsenical sprays applied to potatoes will serve to keep them in check upon these plants. A mixture of arsenate of lead, three pounds in fifty gallons of water, if sweetened with cheap molasses or syrup, makes a fairly effective spray.

When alfalfa or other crop is seriously attacked, any remedial measure, to be effective, should be applied at once. Alfalfa may be sprayed with arsenicals as above indicated, in which case more than one application may be necessary, and the sprayed portions should not be used for hay.

Dean suggests, the field may be "beaten" with branches by a line of men or children, driving the beetles before them to the edge of the field where rows of dry hay or straw have been previously placed. The insects will run beneath these rows for shelter and may then be destroyed by burning.

The Alfalfa Caterpillar (*Eurymus eurythene* Boisd.).—The sulfur-yellow butterfly producing the alfalfa caterpillar is common practically over the entire United States and the southern part of Canada. It is an insect familiar to almost all young collectors. The wing expanse is about two inches.

Description.—The black band on the wings of the female is more or less dotted with white, these dots being absent in the male. There is a prominent black dot in the center of the fore-wing, and a pale yellow spot in the center of each hind-wing in both male and female.

Life History.—The small, spindle-shaped eggs are laid on green alfalfa. These hatch into dark-green worms, about one inch long when full grown, with a light stripe on each side, interrupted by black and red dots. The chrysalis is greenish yellow, and is attached, head up, by two threads to a stalk of alfalfa or to weeds and grasses. The winter is passed in this stage. It probably has two or three broods.

Injury.—This insect is extremely abundant in the West where large fields of alfalfa occur, and it is a serious pest to this crop. This is particularly true in California, Arizona, and other parts of the Southwest.

Enemies.—A contagious intestinal disease, resembling somewhat in effect flacherie of the silkworm, may be in part responsible for keeping this butterfly in check in portions of California and Arizona (Circular 133, U. S. Bureau of Entomology).

The caterpillar is preyed upon by Tachina flies and by hymenopterous parasites. The cotton boll worm is also said to attack it.

Control.—Pasturing the affected fields is recommended. Also, keep the soil in the best cultural condition. Irrigate frequently, and immediately after the crop has been cut and the hay removed. Renovate by disking. Cut the alfalfa close to the ground, and cut earlier than the general rule. Always cut a few days before it is in blossom. Turkeys and chickens, if allowed to run in the fields, will reduce the number of caterpillars. Coöperation on the part of all farmers in an infected district is necessary.

INSECTS ATTACKING BEETS

The Beet Aphis.—This louse (*Pemphigus betæ* Doane) is found in clusters on the small rootlets of the sugar beet, and is very destructive in some of the Pacific Coast states. Infested beet plants fail to make normal growth, and the beets become soft and spongy. Small rootlets are attacked, cutting off the plant food supply. A plant badly infested indicates its condition by wilting of the leaves, and if the plants are small they may die as a result of the attack.

Life History.—Several generations occur in a season, and winged individuals appear from time to time. These winged forms are usually found in the fall, at which time they fly to cottonwood trees and give rise to true sexual forms. After mating, the female deposits a single winter egg in a crevice of the cottonwood bark. In the spring this egg gives rise to a louse, which forms a gall on the cottonwood. A single generation of lice are produced in the galls. These are all winged and migrate to beets, weeds, and grasses, there giving birth to young, which descend to the roots and start new colonies of winged viviparous females.

Control.—But few measures of control are known. Scientific rotation of crops is advised, and it is suggested that root crops be not grown on the same land year after year.

INSECTS AFFECTING CORN AND SUGAR CANE

A number of insects affecting the corn crop are treated under other heads. The corn ear-worm eats into bolls of cotton and is called also the cotton boll worm. (See page 218.) It also bores into the fruit of tomato, and attacks corn in the silk. The chinch bug is a serious enemy of corn, wheat, and other crops. (See page 191.)

The Corn Leaf Aphis.—This plant louse (*Aphis maidis* Fitch), like most others of the family, has both winged and wingless forms. The wingless lice are pale green in color, and the winged lice are black and green (Fig. 217). They appear in midsummer, at which time they may be found on young corn leaves, where they continue until cold weather.

Injury.—This insect is rarely injurious, but heavily infested leaves turn yellow or red and may shrivel and die, especially in dry weather.

Control.—Numbers of insect parasites help to control it under normal conditions.

The Corn Root Aphis.—These are bluish-green lice (*Aphis maidi radicis* Forbes) found on the roots of corn, from which they suck the sap.

Description and Life History.—The species is dependent upon colonies of small brown ants, *Lasius niger americanus* Em. The ants carry the eggs into their nests, bringing them into the sunlight on warm days and carrying them below the frost line in cold weather. The young are carried by the ants to suitable weeds until the corn gets up, when the ants transfer them to the corn. The lice multiply very rapidly, living young being produced by the females. There may be a dozen generations during the season.

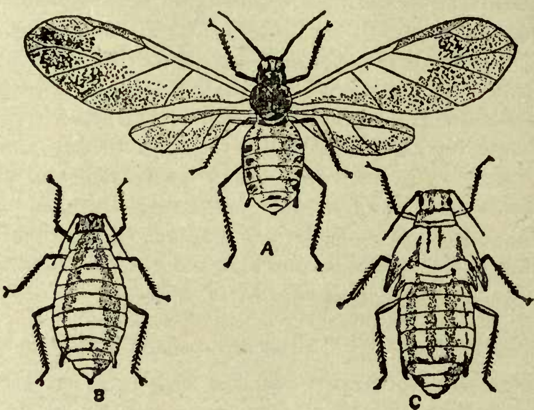

Fig. 217.—The corn leaf-aphis, winged and wingless females and nymph. (After Forbes.)

In some broods winged individals occur, and these migrate to new fields. Corn is not the only plant damaged, for squash, pumpkin, strawberries, cotton, etc., may be attacked and become stunted and lack color in consequence.

Control.—Plow and harrow in the fall to break up nests of ants. Keep fields clear of weeds to deprive lice of food in the spring. Rotation of crops should be practiced. Thorough cultivation and proper fertilization are desirable to induce vigorous growth.

The Sugar-cane Beetle.—This is a robust black beetle (*Ligyrus rugiceps* Lec.) about one-half of an inch long, with stout, coarsely spined legs. Eggs are laid in the ground on weakened or decaying roots. The grub burrows in the stalks of corn and sugar cane (Fig. 218). The corn is usually killed. Injury occurs early in the growing season. The grub pupates in the fall, the

beetles hibernating in winter in the soil of the fields. One generation is produced annually.

Control.—Practice spring plowing and cultivation. Rotation of crops and clean cultivation are advised.

The Western Corn Root Worm.—This worm or grub (*Diabrotica longicornis* Say) is two-fifths of an inch long. It is slender, and is whitish or yellowish, with a black or brown head. It produces a small, greenish beetle one-fourth of an inch long (Fig. 219).

Life History.—The beetle lays its eggs in the soil of corn fields in the fall and then dies. The winter is passed in the egg stage, the eggs hatching after corn is planted in the spring. After that time until fall the grubs are found at the roots of the corn. The beetles, in late summer and until cold weather appears, are found on or about the silk of corn and on late summer flowers, such as thistles, golden-rod, and red clover. They disappear at once on the advent of cold weather.

Injury.—By mining in the main roots of the corn, the worm checks the plant's growth and may cause its death.

Control.—Practice crop rotation. Corn planted the year following another kind of crop will not be injured.

Fig. 218.—The sugar-cane beetle. (U. S. Bu. Ent.)

The Army Worm.—The full-grown caterpillar of this species (*Heliophila unipuncta* Haw.) is nearly two inches long. It is either of a dark gray or dingy black color. It has three narrow, yellowish stripes above and a smaller, darker one at each side.

It closely resembles some of the cut-worms and is, in fact, a member of that family. The moths are among the most common of the so-called "millers." The front wings are clay or fawn colored, speckled with black scales. The hind-wings are somewhat lighter, with blackish veins and darker margins.

Life History.—There are two or three broods a year. The winter is passed in the larval stage. The moths first appear in early spring. The female lays from ten to fifteen eggs at a time near the unfolded bases of the leaves of grass. One female may

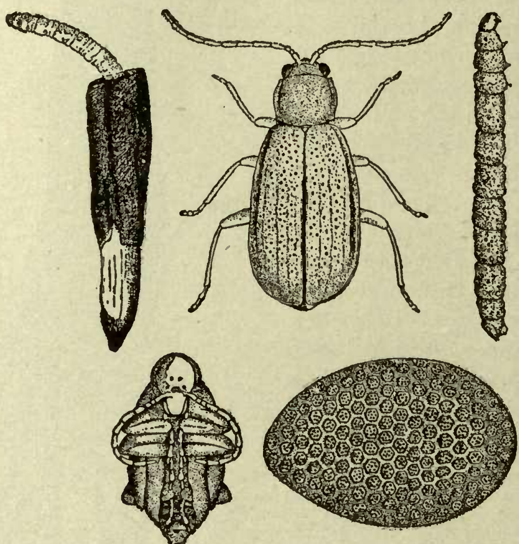

Fig. 219.—The western corn-root worm, egg, larva, pupa, imago. (After Forbes.)

lay seven hundred eggs. Ten days are required for hatching and from three to four weeks for the larvæ to become full grown. When mature, the caterpillars enter the ground, transforming into pupæ, and the adult moths emerge in two weeks and immediately lay eggs for the next generation.

Injury.—As their name indicates, these caterpillars frequently travel in large numbers in search of food. They feed entirely at night, and whole fields of corn or other grain may be destroyed before their presence is realized. Grasses form their favorite food, and the heads of grasses are frequently cut off. Various garden crops are also injured. Clover, however, appears to be almost

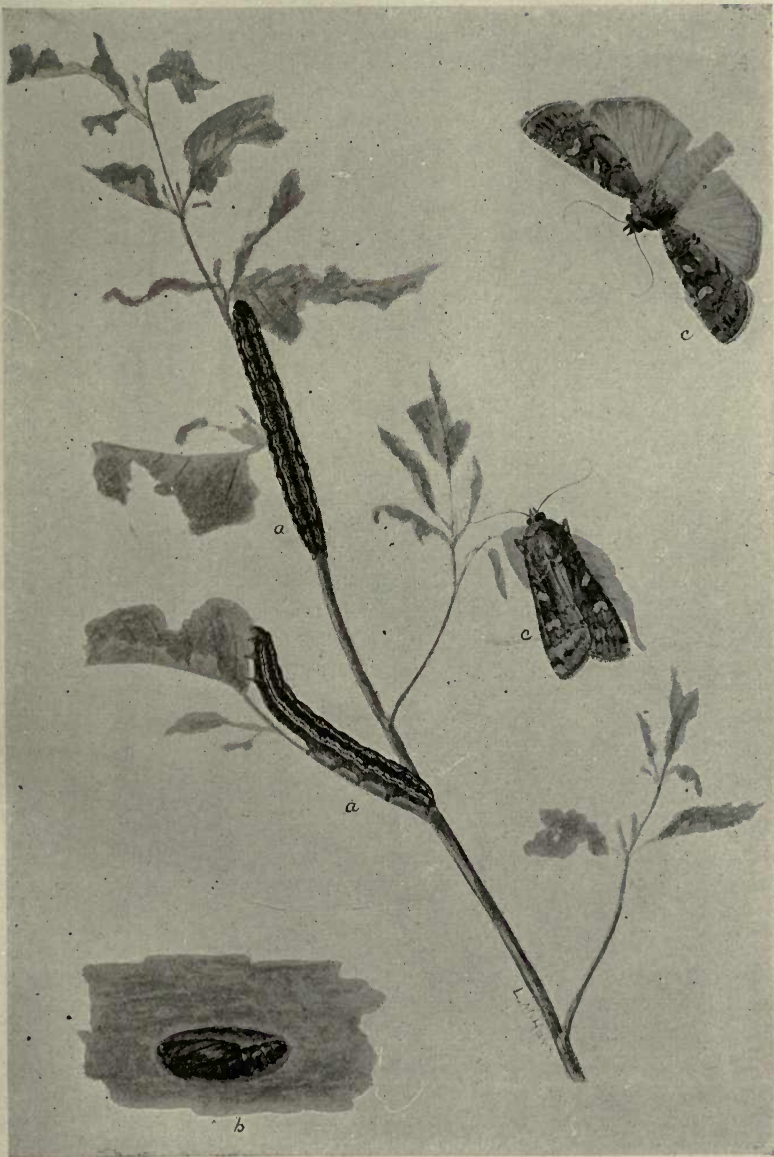

FIG. 220.—The erratic army worm, caterpillars, moths, and pupa. (Lugger.)

immune; it is, however, eaten if found in the line of march. Figure 220 illustrates a closely allied form.

Control.—Various parasitic two-winged and four-winged flies attack it. Barriers may be constructed to check its march. These are described in connection with another form of army worm, and also in connection with remedies advised for chinch bugs.

Deep fall plowing and thorough harrowing will help to destroy hibernating larvæ. Where safe and feasible, burn the grass along fence rows and hedges or waste places where larvæ normally live. A strip four feet wide across their line of march, dusted or sprayed with Paris green or other arsenical poison, may be effective. When gathered in furrows plowed to check their march, they may

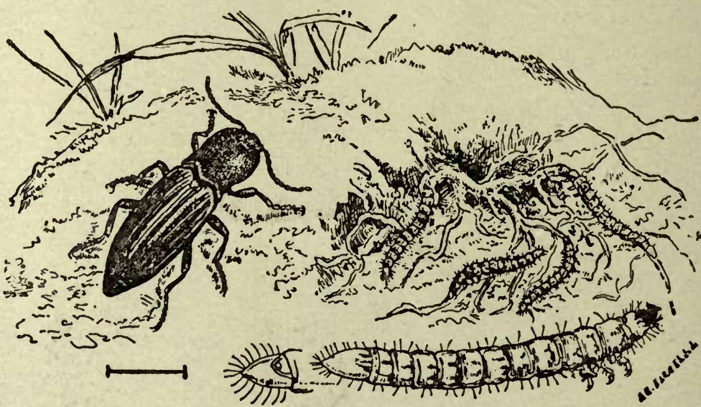

FIG. 221.—Wire worm and "click beetle."

be destroyed by spraying with pure kerosene or crude petroleum, or straw may be placed over them and burned. Whatever remedy or remedies are chosen by the farmer, prompt action is necessary in order to save certain crops.

Wire Worms.—The adults are known as click beetles (Fig. 221) or snapping beetles, from the fact that if they are placed upon their backs they recover their normal position by a quick contraction of muscles, causing the forceful moving of the thorax upon the abdomen, which is accompanied by a clicking sound. They are from one-half to three-fourths of an inch long. They are brown, brownish gray, or black in color. Their larvæ, called "wire worms," are slender, cylindrical, hard, shining brown or yellow grubs, about three-fourths of an inch long (Fig. 222).

Habits.—Native sod or old pasture land is the natural home of these insects, and for the first two years after sod, crops should be chosen, whenever possible, which are not attractive to wire worms. The worst damage occurs in the second year after planting grass land in grain, and it is believed that from three to five years are required for the life cycle of the various species. The last year of the larval stage is passed in a small cell, where it transforms to a pupa.

Injury.—There are many species of these insects (*Elateridæ*). They attack a large variety of crops. The seed of corn suffers, as does also the seed of cotton and young cotton plants. Young wheat plants, potatoes, turnips, young corn, and many garden and farm crops are attacked. The worst damage occurs in the case of corn.

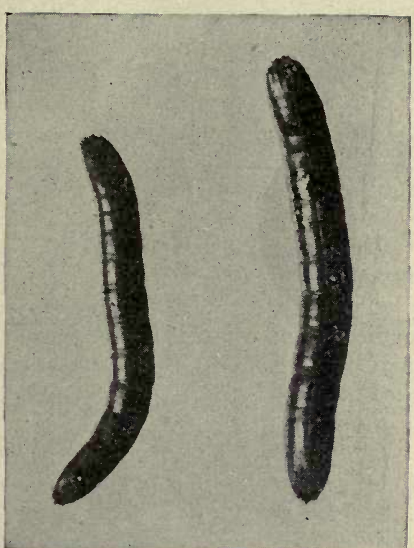

FIG. 222.—Wire worms. (Enlarged.)

Control. — Suitable crop rotations, early fall plowing, and thorough cultivation are recommended. As a rule, legumes are not injured by these insects. It is therefore wise to include a legume with the rotation. Land should not be allowed to lie in a grass crop several years. On a small scale when occurring in kitchen gardens, these grubs can be trapped by pieces of potato put on short sticks and buried near plants that are threatened. Summer fallowing, where possible, is desirable, for it keeps all growth which might serve as food off the field. Any farm practice which is practical and which will stimulate early growth is recommended. This enables plants to better withstand attack. For example, the early planting of corn in the southern states, followed by frequent cultivation, is good. Corn should not be planted two years in succession on the same ground, particularly if the field is infested. Corn or other grain crop following sod is likely to suffer from wire-worm attack.

Southern Corn Root Worm, Bud Worm, or Drill Worm.*—The larva of this beetle (*Diabrotica 12-punctata* Oliv.) is particularly injurious to corn in the South. Plants are weakened and die from its attack. There are probably three or four generations in the southern states. Eggs are laid at the base of the plant and hatch in a few days. The grubs at once burrow into the stalks, at the surface of the ground or just below it. Even if an infected plant does not die, it will not, in all probability, produce marketable ears.

Control.—Intelligent crop rotation and fall plowing are the only practical remedies. In rotating crops, cotton may follow or precede corn, as may most of the grasses and many vegetables. Since this insect attacks curcubits, such as melons, squash, pumpkins, and cucumbers, they should be kept out of such rotation. It also attacks beans, and hence these should be prohibited in any rotation plan. An excessive amount of seed in each hill would probably insure the proper maturing of some of the stalks. Late planting and the draining of bottom lands used for corn are recommended.

The Angoumois Grain Moth.—This moth (*Sitotroga cerealella* Oliv.) is about one-quarter of an inch long. It is brownish or buff colored with fringed wings. Its grub is white and somewhat smaller. The original infestation occurs in the field, where there may be as many as three generations. These generations are continued in the corn crib, granary, or seed-house. The larvæ in infested kernels are brought in with the harvested grain.

Injury.—In different parts of the country, notably in the South, stored corn and other grains are infested with the larvæ of this moth. Its work is first made apparent by the appearance of tiny holes in the kernels, and the entire contents of the kernel may be destroyed, thus rendering it useless for seed or market.

Control.—Corn with the husk on is not so liable to be attacked. Hence, corn husked late in the season, after the advent of cold weather, and stored in cribs will suffer but little. Corn and other grains, however, stored in seed-rooms or in bins early in the season may deteriorate during fall and winter, owing to the continued work of this pest. Such grain should be watched, and upon the first appearance of the pest or upon indications of its presence, the grain should be fumigated twice, or, if necessary, three times, at intervals of two weeks. Use six pounds of bisulfid of carbon

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* See page 218, under insects attacking truck crops; also page 217, rice insects.

to every one thousand cubic feet of space, because this insect requires intensive fumigation. (See fumigation methods, Chapter VI.)

Corn Bill Bugs, or Curlew Bugs.—These are weevils or snout beetles, and are of wide distribution. One species is slate colored, about three-quarters of an inch long. Another is only one-quarter of an inch long and black in color (Fig. 223). In a general way the life history of the many species is the same.

Life History.—After hibernating in rubbish they lay their egg usually on the roots of rushes or sedges. Grubs or larvæ hatched from these eggs are white, with brownish or blackish heads.

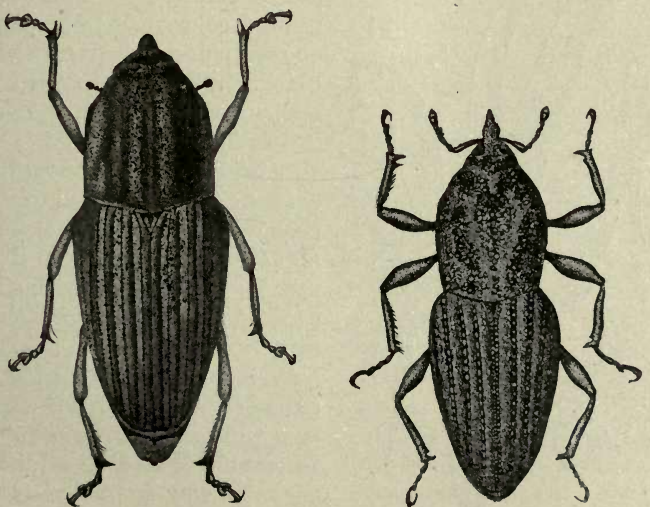


Fig. 223.—Two different species of corn bill bugs.

Injury.—They often injure corn, particularly if it is planted on low, sedgy land, by eating into the tissues of the plant, thus causing the elliptical holes seen when the corn leaves are unfolded (Fig. 224). A southern form of bill bug is restricted in its range to the more southern states.

Control.—Early planted corn in the South (March and April) shows less injury than the same crop when planted later. Rotation of crops, generous fertilization, good drainage, late summer or early fall and winter plowing, are all advised as methods of control. Plowing, in the case of grass land or recently cleared

lowland, is an important measure. It is well, however, not to follow sod or newly cleared swamp land with corn, but to plant flax, potatoes, or other truck crops the first year. Swamp or grass land infected with bill bugs may be burned over.

The Corn Ear-worm.—The caterpillar of this moth, which belongs to the family of cut-worms, is also known as the tomato fruit-worm, tobacco-bud worm, cotton boll worm, etc. (*Heliothis obsoleta* Fab.). It gives rise to a dull olive-green or yellowish moth, about three-fourths of an inch long. The caterpillars themselves are variable in color; they are generally striped, but the ground color may be light green or rose color or brown or almost black. When full grown they are nearly one and one-half inches long.

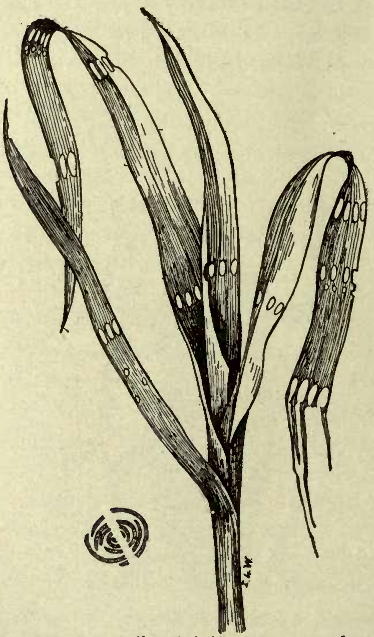


Fig. 224.—Details of injury to corn plant by bill bugs.

Life History.—The moth lays eggs for the first brood on corn, peas, beans, or almost any available food plant. In from three to five days these eggs hatch and the caterpillars of the early broods attack the corn when it is about knee-high. They feed in the axils of the leaves. It requires two and one-half weeks for them to reach full size, at which time they burrow from two to five inches in the soil, at the base of the plant. The pupa is four-fifths of an inch long, shining reddish brown in color, and it gives rise to the moth in about two weeks, making its complete cycle in warm weather in something over one month. It may have three broods in favorable latitudes. Winter is passed in the pupal stage.

Injury.—The caterpillars of the second and third generations feed upon the silk of the corn ears, and eat out the kernels at the end of the cob, furnishing favorable conditions for moulds which may do further injury.

It is estimated that the annual damage in the United States

from this insect alone is something like fifty million dollars. (See page 223, under, cotton insects.)

Control.—Land should be plowed in the late fall in order that the pupæ may be turned up to be subjected to the variations in weather, and where it is practicable and in line with good farming the land should be harrowed. The early plantings of corn generally escape injury, since corn passes the silking stage before the moths of the second brood appear. Caterpillars of the first brood may be killed by applying a spray of arsenate of lead—two pounds

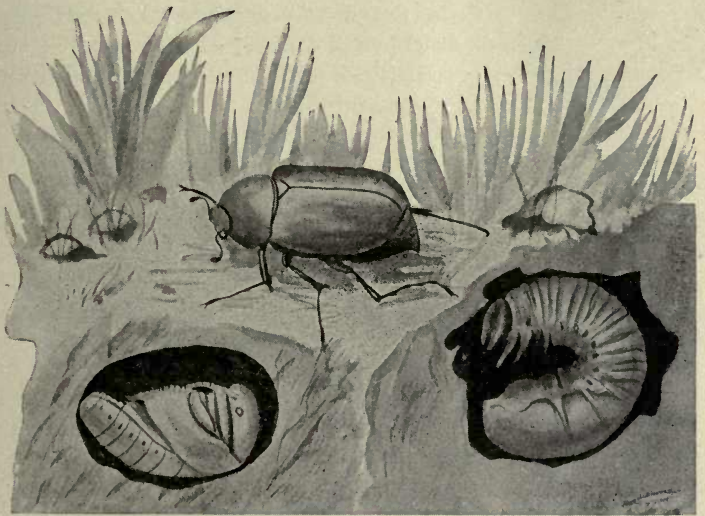


Fig. 225.—May beetle or "June bug"; larva or white grub pupa and adult. (After Linville and Kelly.)

to fifty gallons of water. This will not injure the plant tissue. Better still, powdered lead arsenate may be dusted into the funnel of the young plants. Spraying the silk with a mild poison is now being tried with some success in killing the young caterpillars of the second and third broods. Dusting the young silk with poison is sometimes tried successfully.

White Grubs.—These destructive grubs sometimes feed on the roots of corn. For the life history and an account of injury, see page 135, under insect pests of berries and grapes.

Sod land is the natural home of this insect. It should be plowed early in the fall to destroy the pupæ and tender adults.

Crop rotation is, of course, advisable, as is also pasturing with hogs. Figure 225 illustrates the different stages; and two eggs, much enlarged, are shown in Figure 226. These eggs are laid in sod.

The Stalk-borer (*Papaipema nitela* Gn.).—This moth lays its eggs in the autumn upon ragweed, dock, and other plants which are normally the food of its larvæ. The young larvæ climb to the leaves and first mine small galleries in the leaves. When the leaves are riddled, they work down the bases and enter the stalks. After one plant is destroyed, the worm may migrate some distance and attack another. Infested plants wilt above the point of injury. This pest is sometimes noticed in corn and is entered as a corn pest.

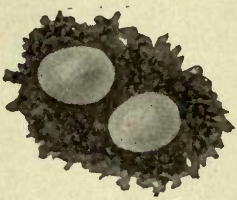


Fig. 226. — Eggs of May beetle. (Original.)

Control. — Clean farming is the best method of control. Weeds in the vicinity of the garden should be destroyed by removal and burning in early spring. The insect has many parasitical enemies, and the injury is largely local in nature. Infested plants should be promptly destroyed where practicable, to prevent the migration of the worm to another plant and thereby increase the damage. Little trouble will be experienced in fields that are clean.

TURNIP INSECTS

Field and garden turnips are frequently infested with plant lice. No practical remedy is available, as kerosene emulsion cannot easily be sprayed on the under side of the leaves. Parasites help to keep them in check. The cabbage maggot is also a turnip pest.

BARLEY, TIMOTHY, RYE, AND GRASSES

These crops are all injured to a greater or less extent by insects described under other heads and in all cases the treatment is practically the same as that already given. See corn and small grains.

On timothy one frequently finds the false chinch bug (*Trapezonotus nebulosus* Fab.), often mistaken for the true chinch bug, since it has the same bedbuggy odor. It also resembles it somewhat in coloration and belongs to the same family. Timothy is rather seriously injured by this bug, which is, generally speaking, a feeder upon weeds.

INSECT PESTS OF SUGAR BEETS

Flea Beetle (*Disonycha xanthomelœna* Dalm.).—This is a small black flea beetle which, with its larva, eats holes in the leaves of beets. The adults hibernate, laying eggs on the crown of the plant in the spring. Plants so affected may be dusted or sprayed with arsenate of lead.

INSECT PESTS OF THE ONION

Onion Thrips.—A very small insect belonging to the order *Thysanoptera* (*Thrips tabaci* Lind.).

Description.—Adults and larvæ eat the epidermis of onion leaves, causing them to wilt, turn white, and die.

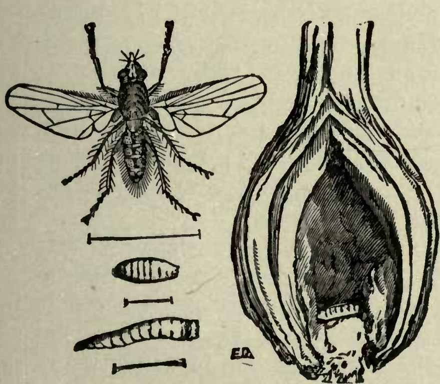


FIG. 227.—The onion maggot.

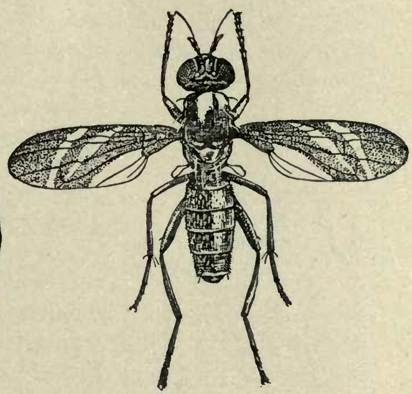


FIG. 228.—*Tritoxa flexa.*

Control.—Tobacco extracts afford the best spray for this pest. Three-quarters of a pint of nicotine sulfate in one hundred gallons of water, with four or five pounds of soap added, is recommended by the Cornell Station. Three sprayings should be given at intervals of four or five days. Weeds should not be allowed to grow about the edges of the field.

Two Onion Maggots.—One of these maggots (*Pegomyia ceparum* Bouche) (Fig. 227) is a common pest of the onion, causing the leaves to yellow. As a result of its attack, the plant generally dies. *Tritoxa flexa* (Fig. 228) gives rise to a maggot which may also work in onions.

Control.—Old, infected fields should not be used for onions; rotate the crop and thus avoid this enemy. The poison spray

recommended for cabbage maggot, page 232, can be well used against onion maggots, which closely resemble cabbage maggots in appearance and life history.

INSECTS AFFECTING HOPS

The Hop Plant Louse (*Phorodon humuli* Schr.).—The hop louse, which was introduced from Europe about the time of the Civil War, is light green in color. The summer is passed on the vine and both winged males and females migrate to plum trees in the fall, where wingless females are produced and fertilized by the males. Eggs are then deposited upon the twigs of plum and in axils of buds. The "stem-mothers" hatch from these eggs in the spring, giving rise to two or three broods of wingless viviparous females (Fig. 229) before winged migrants are produced. The migrant flies to the hops and continues to bring forth females asexually until the fall. In warm parts of the country it has been shown that this louse may remain the entire year on the hop, and some may stay on the plum during the summer.

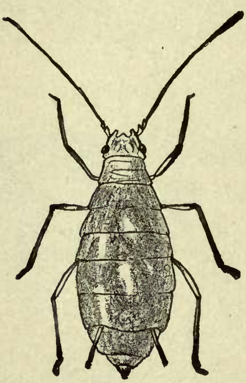


Fig. 229. — Hop-plant louse, female. (From "Insect Life.")

It will be noted that in a general way this aphis follows the same general rule, as regards reproduction, that is observed in connection with other plant lice. For further information on the reproduction of plant lice, see page 14.

Injury.—This is probably the most serious pest of hops. The hop plant louse not only draws the sap from the vines, but by exuding a "honey dew," which drops to the leaves below, coats the surface of the leaves with a glistening film, which affords an excellent medium for the growth of a fungus, giving to the vines a dark, blighted appearance.

Control.—Where this pest is abundant, spraying with whale-oil soap, quassia chips, or with tobacco extract gives relief if done thoroughly and before the lice become too numerous. After the leaves are curled as a result of their attack, it is much more difficult to hit them with a spray. A solution of quassia chips is made by soaking eight pounds of chips in sufficient water to cover them, for a few days; then boil for about one hour; add one hundred gallons of water and five pounds of whale-oil soap. If the latter

cannot be obtained, soft soap may be used. Nicotine sulfate, one part to three thousand parts water and four pounds of whale-oil soap in every one hundred gallons of spray, is effective. Fish-oil soap may also be used in place of whale-oil soap, if the latter is not procurable.

Red Spider (*Tetranychus gloveri* Bks.).—Brownish, shrivelled, and dropping leaves, or spotted, discolored, and imperfect cones, on hops indicate the presence of a small mite called red spider. The loss occasioned by this pest may run as high as fifty dollars per acre. The adult and eggs of this species are found on the under side of the leaves. The winter is passed on vegetation adjoining the fields. Reproduction is rapid and injury to plants severe.

Control.—Fall plowing and doing away with weeds and other vegetation which offers winter food and shelter should be practiced. Particular attention should be given to weeds at the edges of fields. The sprays recommended for the hop aphis are advised for the control of this pest, particularly the use of nicotine sulfate with soap. Several applications should be made. A soap solution alone, consisting of one pound of soap to two gallons of water, is also effective if used at the very first appearance of the insects.

This is also a cotton insect. (See page 221.)

RICE INSECTS

Rice Water Weevil or Rice Root Maggot (*Lissorhoptus simplex* Say).—The adult weevil is gray in color and only about one-eighth of an inch long. It may be seen swimming either on the surface or below. The eggs, barely visible to the naked eye, are deposited upon the roots or in the mud. The larvæ or maggots, according to Hood, are found in the rice fields in from one to three weeks after turning on the water. Two broods may appear in one season. The winter is passed in the adult stage (Fig. 230).

Injury.—This is the principal insect enemy of rice plantations; it also attacks wild rice, feeding as a larva on the roots, at which time the least injury is inflicted on the plant. The adult snout beetles feed on the leaves. The vitality of the plant is thus weakened and its bearing qualities impaired. After attack the leaves turn yellow and the plant wilts. In addition to rice, this weevil is known to feed upon water lilies and other aquatic plants, and possibly upon a few grasses. Rice growing in running water does not suffer.

Control.—Draining the rice field completely will kill the larvæ.

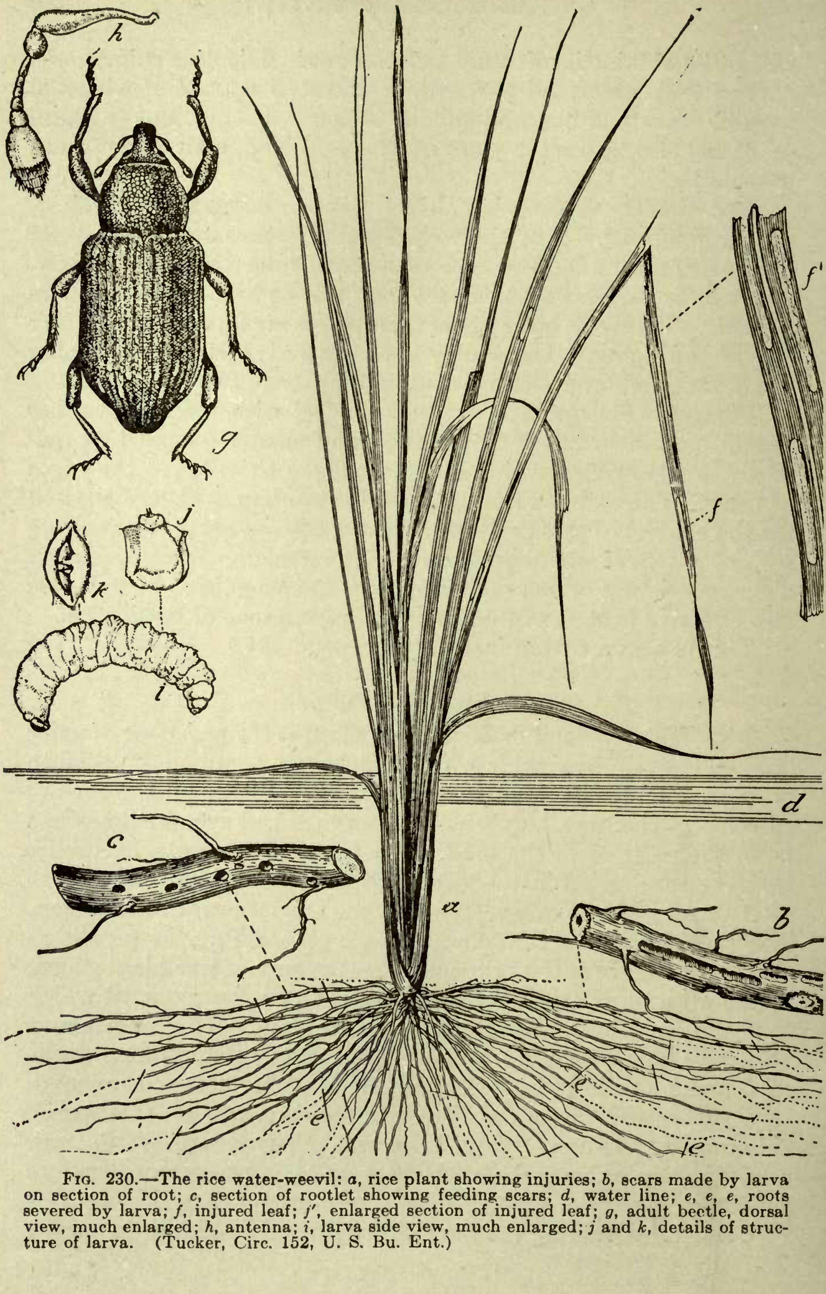


FIG. 230.—The rice water-weevil: *a*, rice plant showing injuries; *b*, scars made by larva on section of root; *c*, section of rootlet showing feeding scars; *d*, water line; *e*, *e*, *e*, roots severed by larva; *f*, injured leaf; *f'*, enlarged section of injured leaf; *g*, adult beetle, dorsal view, much enlarged; *h*, antenna; *i*, larva side view, much enlarged; *j* and *k*, details of structure of larva. (Tucker, Circ. 152, U. S. Bu. Ent.)

The ground so drained should be allowed to dry. This should be done before a large number of the plants have become weakened. Tucker (U. S. Bureau of Entomology, Circular 152) recommends alternate flooding and drying. Freeing ground, by cultivation, of all weeds and grasses, and doing away with depressions and dead furrows, is desirable.

Rice Stalk Borer, or "White Blast."—The caterpillar of this insect (*Chilo plejadellus* Trinck) bores in the rice stem. This attack causes the head of the infected plant to die and become light colored, hence the term "white blast."

Control.—It is recommended that one should burn over the fields in winter, destroying all volunteer rice, weeds, etc., on the edges of the field. If this is not practical, cut all volunteer weeds and rice close to the ground, taking them away from fences, and burning them in a safe place.

Rice Grub (*Chalepus trachypgnus* Burm.).—The adult insect is shiny black, two-thirds of an inch long. The larva is white. Overflowing is recommended as the best remedial measure.

Corn Root Worm.—J. B. Garrett, of Louisiana, says he has seen whole fields of rice ruined by the southern corn root worm (*Diabrotica 12-punctata*). See page 240 for a discussion of this insect. Drowning out by flooding is recommended for this pest.

Enemies of Stored Rice.—Attacks on stored rice are made by the rice weevil (see page 347) and other mill and warehouse insects. All of these are controlled to a greater or less extent by fumigation. Rice held in cold storage will escape attack. Termites or white ants (*Termes flavipes*) are said, by Garrett, to sometimes attack stored rice.

PEANUT INJURIES DUE TO INSECTS

Stored Peanuts.—Many of the tender shells of peanuts are broken by machine handling and by the workmen climbing over stored sacks. This invites the attack of the Indian meal moth, described under mill insects, page 349. One or more of the flour beetles, saw-tooth grain beetles, and others also attack stored peanuts.

These insects all yield either to the "heating method" or fumigation. The heating method consists in tightly closing all openings in a storeroom or warehouse and keeping the temperature at from 120 to 125 degrees F., but not above the latter figure, for eight or ten hours. When this method is not available, fumigation with

hydrocyanic acid gas or with bisulfid of carbon may be employed. (See page 61.)

A species of aphis works on the roots of peanuts. This calls for crop rotation; the same land should be used for peanuts only once in four or five years. (U. S. Farmers' Bulletin 356.)

INSECTS ATTACKING TOBACCO

Southern Tobacco Worm.—This sphinx moth (*Phlegethontius sexta* Johan.) is perhaps the most destructive insect with which tobacco growers have to contend. In the larval stage it is a green worm with seven oblique, whitish lines on each side. It is about two inches long when full grown. On the posterior end of the body is a prominent horn. It pupates slightly below the surface of the ground. It emerges as a brownish moth with a few white dots at the base of the front wings. There are two broods. The winter is passed in the pupal stage.

The Northern Tobacco Worm.—This closely resembles the above species and has practically the same life history and yields to the same treatment. In the caterpillar stage it is a voracious feeder and destroys an enormous number of plants. The two insects cause an annual loss of nearly nine hundred thousand dollars in the southern states.

Enemies.—Several insect parasites attack tobacco worms, and the common skunk eats both larval and pupal forms. The caterpillars are also attacked by fungous and bacteriological diseases.

Control.—Three sprayings with arsenicals, preferably arsenate of lead, or dusting the plants with powdered arsenate of lead is recommended. When powdered arsenate of lead is used it should be applied in the early morning, when the leaves are wet with dew. It will be effective until washed off by frequent or copious rains. All traces of this insecticide on leaves at harvest time should be removed by spraying with water after sunset. Picking by hand may be practiced where help is abundant and cheap. Hand-picking among growers is perhaps more popular than treatment with arsenicals.

Bud Worm, Cotton Boll-worm, or Corn Ear-worm.—In the South this moth sometimes lays its eggs in the buds of tobacco, the worm feeding upon the tender, unopened leaves. When treatment is necessary, dusting the buds with cornmeal poisoned with Paris green has been found most effective. About two teaspoon-

fuls of Paris green should be mixed with a quart of cornmeal. (See also page 210.)

The "Suck Fly."—In spite of its name, this insect (*Dicyphus minimus* Uhl.) (Fig. 231) is a true bug, and has in recent years become quite troublesome to tobacco growers.

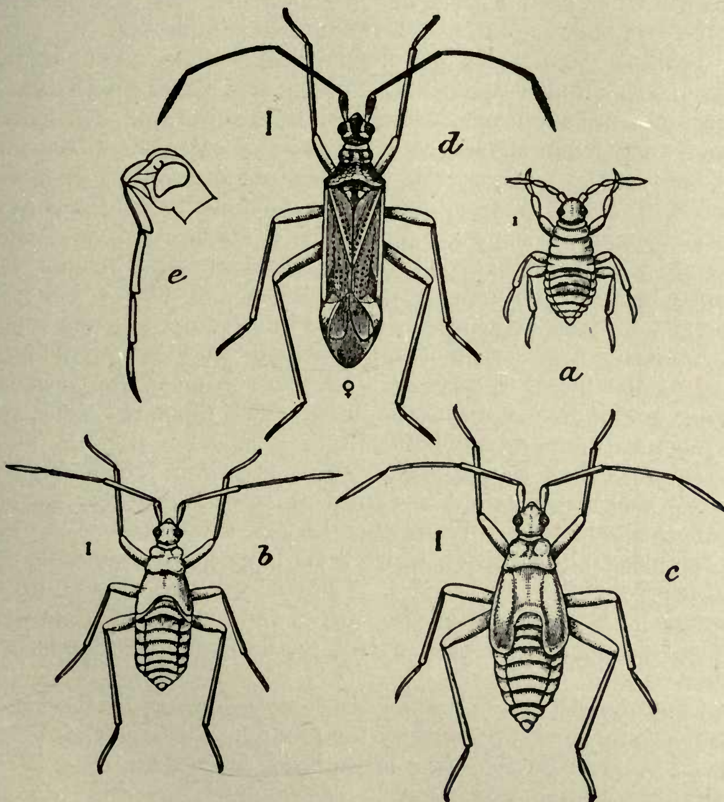


Fig. 231.—The so-called "suck fly": *a*, *b*, *c*, nymphs in different stages; *d*, adult female; *e*, head and beak from side; all figures much enlarged. (L. O. Howard, U. S. Bu. Ent.)

Life History.—The insects are found on both sides of the leaves, affecting the under side of the nymph or imperfect stage. The eggs are said, by Quaintance, to be deposited singly within the tissue of the leaf and they require about four days for hatching. The entire cycle of one generation is completed in about fifteen days.

Injury.—Leaves of the second crop of tobacco are injured by this pest sucking the sap from the leaf tissue, causing it to yellow and rendering it nearly worthless.

Control.—Tobacco extracts applied by spraying both upper and lower surface of the leaves appear to give the best results. The strength to be used is given on the containers. Early application at the very first appearance of the insects is desirable.

Tobacco Leaf-miner or **"Split-worm."**—The adult of this insect (*Phthorimola operculella* Boisd.) is a small moth whose wings measure about one-half an inch from tip to tip. The female lays its eggs upon the leaves, and the small caterpillars bore into the body of the same, causing discoloration and sometimes a misshapen leaf. The gray blotches due to the miner in leaf tissue have been thought by some growers to be a disease and have been referred to as "weather rot." The caterpillars do not remain constantly between the upper and lower surface of the leaf, but may emerge and, after crawling about the surface, enter at a new place.

Control.—Destruction of all leaves made worthless by the presence of the insect is advised. Destruction of all weeds in the spring, particularly horse nettle, upon which the insect feeds, will do much to reduce its numbers.

Tobacco Flea Beetle.—This small brownish beetle (*Epitrix parvula* Fab.) is abundant in almost all tobacco-growing districts in the United States. When abundant its attacks cause the leaf to exhibit small dry spots, which grow larger, and eventually the leaf becomes full of small holes. These afford entrance to fungous diseases. Eggs are laid at the base of the plant, and the young grubs feed upon the roots. Plants of the nightshade family are attacked also.

Control.—All weeds, especially those belonging to the nightshade group, should be kept off the ground. Particular attention should be given to the edges of the field, fence rows, etc. Clean cultivation is most important.

Cut-worms.—Several species of cut-worms attack tobacco. These are generally well controlled by the use of a poisoned bran mash made by mixing Paris green and bran until the latter is decidedly green in color; then add water and sweeten with molasses or syrup just before using. This bait may be placed in a ring around each plant and a short distance from the plant, or small amounts placed at frequent intervals among the plants. Care should be taken not to place this bait too close to a plant, for bring-

ing the Paris green into contact with the roots through the agency of rains should be avoided. The bait is best placed in the field at sundown in order that it may not become dried by the sun before night, which is the chosen feeding time of cut-worms.

Other insects which at times injure tobacco are: The cabbage plusia, grasshoppers, white flies, and crickets. Naked snails or "slugs" are at times injurious. The so-called cigarette beetle works on stored tobacco and is combated by fumigation with carbon bisulfid.

INSECTS AFFECTING THE COTTON PLANT

The Cotton Boll-weevil.—Undoubtedly this dark-gray snout beetle (*Anthonomus grandis* Boh.) is one of the most destructive insects in America. Introduced from Mexico about 1891, it has gradually spread over nearly the entire cotton belt in the southern states, causing annually a loss of several million dollars. As the name indicates, it works in the bolls of cotton, in which it lays its eggs. Several broods occur in a season (Fig. 232).

Control.—Of all remedies and methods of control which entomologists and growers have tried, the best, if not the only dependable means, consists in early planting, or in the use of early varieties, or in both factors. These are coupled with the use of fertilizers and thorough cultivation in an effort to hasten the maturing and ripening of the crop. Plants should be placed at least four feet apart. This allows the sunlight to reach infested squares which have fallen to the ground, and kills some of the young larvæ therein. The burning or plowing under of infested plants before winter will destroy the quarters where the adults try to hide for winter. Intelligent crop rotations are also recommended.

Red Spider (*Tetranychus bimaculatus gloveri* Bks. Harvey). —Although this is called "red spider," the females may vary in color from red to yellow or green or dark brown. In the South the winter is passed on weeds or cultivated plants, notably the violet, the mites migrating thence to young cotton plants.

Injury.—This mite, which goes under different specific names and attacks a large variety of plants, may cause an immense amount of damage to cotton (Figs. 233 and 234) (see related species, page 215). In 1912 it occasioned the loss of about three hundred and ninety-four thousand dollars in South Carolina alone. Basing estimates upon these figures, it is probable that "during a severe red spider year the Southeast may suffer a loss of two

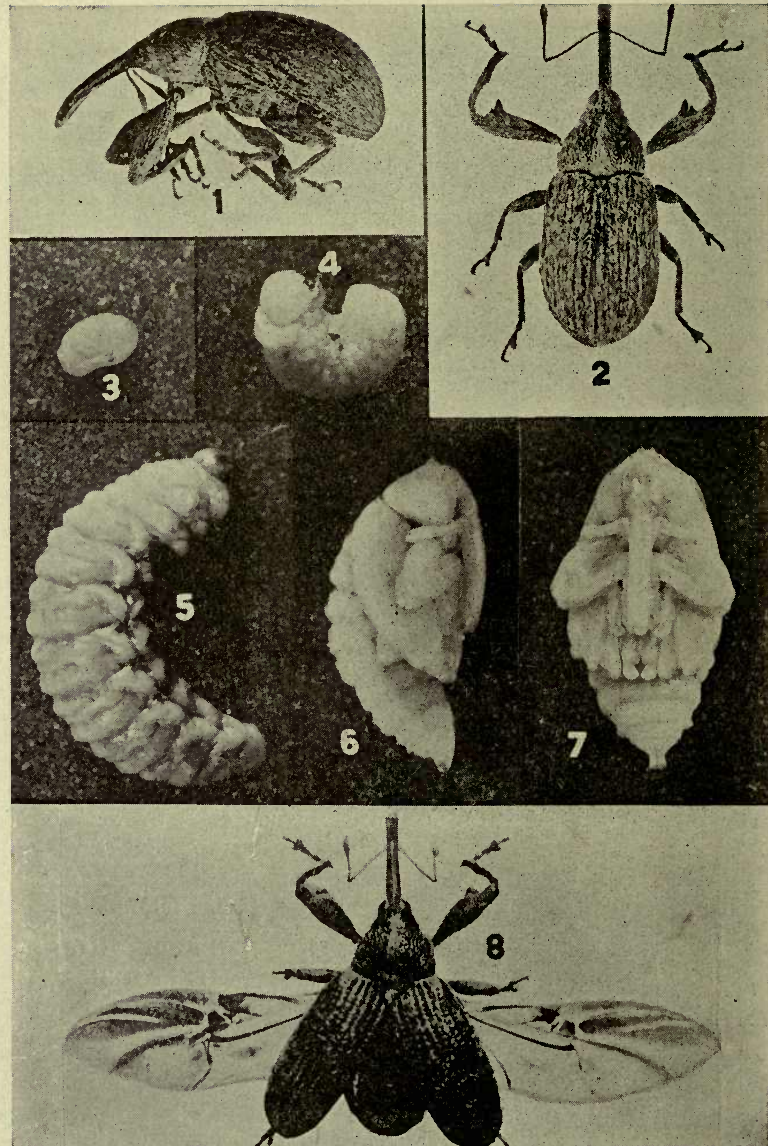


Fig. 232.—The cotton boll-weevil: 1 and 2, adults; 3, egg; 4, grub at beginning of second stage, about three days old; 5, full-grown grub about ten days from the egg; 6 and 7, two views of the pupa; 8, adult with spread wings; figures 3 and 4, enlarged about 20 diameters; all other figures enlarged 10 diameters. (Hinds, Ala. Bull., 188.)

million dollars through the ravages of this pest" (U. S. Farmers' Bulletin 735).

Control.—Destruction of weeds in the winter, and spraying or destroying beds of violets where the mites occur if such beds are near cotton, are recommended. Wide spacing of cotton plants and pulverizing the surface of the ground which renders migration difficult are advised. Spraying compounds which have been found efficient when applied to weeds and other plants are as follows:

(*a*) One pound arsenite of soda in twenty gallons of water. This is very effective, but it is a deadly poison, and care should be taken that animals do not have access to poisoned plants.

(*b*) One ounce of cyanide of potassium in two gallons of water. This is also a deadly poison.

(*c*) One gallon of flour paste in twelve gallons of water.

Whatever spray is employed, there should be two applications, with an interval of seven or eight days between them. Figure 235 illustrates a convenient spraying outfit for treating weeds.

Fig. 233.—Cotton plant in well advanced stage of infestation by red spider. Nearly all leaves, squares and bolls have been shed. (McGregor, U. S. Bu. Ent.)

The Cotton Worm.—The moth producing this worm (*Alabama argillacea* Hubn.) is migratory. Wintering in the most southern districts it moves northward in the spring. It is an interesting fact that it has of recent years been found in states far north of the cotton belt. The caterpillar feeds upon the cotton leaves. The pupal stage is passed upon the leaf. The insect passes the winter in the adult condition. There are several broods.

Control.—Dust the leaves of cotton in the early morning with powdered arsenate of lead.

Cotton Boll-worm.—The caterpillar of this moth (*Heliothis obsoleta* Fab.) eats both leaves and boll. It has several broods. It also attacks tomatoes and corn. (See page 210 for full discussion.)

Control.—Late fall plowing, early spring planting, and crop rotation are recommended. Dusting leaves with powdered arsenate of lead when the young larvæ first appear is also advised. (See page 210, under corn insects.)

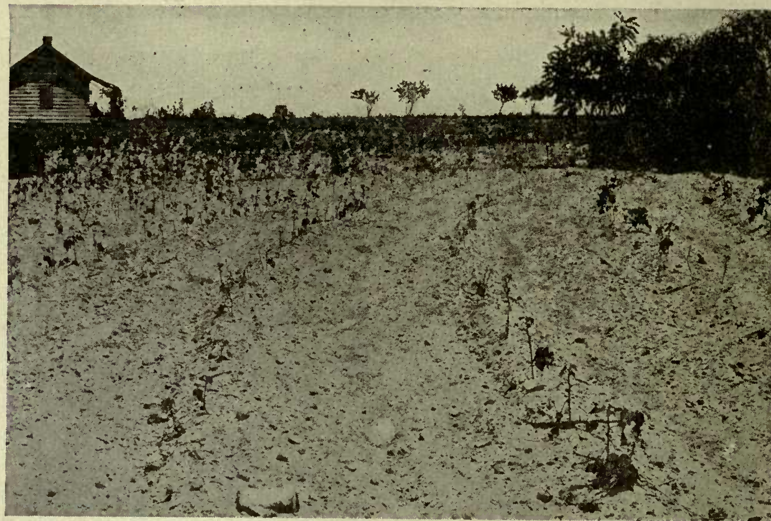


Fig. 234.—A severe example of red-spider work in a cotton field. (McGregor, U. S. Farmers' Bull., 735.)

Fig. 235.—Portable barrel pump for application of arsenate or other herbicide to weedy borders. (U. S. Farmers' Bull., 735.)

Other Insects Injurious to Cotton.—Other insects attacking cotton are the cotton wire-worm, the cotton root-louse, the cotton stainer, page 182, and the pink boll-worm. The last is a newly introduced pest, which bids fair to be very injurious.

QUESTIONS

1. Give the life history of the Hessian fly and methods of control.
2. Describe and give the life history and control measures for the chinch bug.
3. Discuss the wheat-head army worm and compare with the common army worm.
4. Give habits, life history, and remedial measures for grasshoppers.
5. Name, in order of relative importance, the insects affecting alfalfa and give life history and remedies for the first three named.
6. What are wire worms and why are they especially destructive and hard to combat?
7. What are three of the most injurious enemies of corn in the South?
8. Give life history of the hop plant louse.
9. Name two leading pests of rice. Give life history and control measures for each.
10. Name three important insects affecting cotton and give remedial measures for the same.
11. Do the same with tobacco insects.
12. Describe and give the life history of the Angoumois grain moth. How is it injurious, and what means of control are recommended?
13. Which crop is the greatest sufferer from the chinch bug, wheat or corn?
14. What insects are most destructive to field crops in your section?

CHAPTER XIII

INSECTS AFFECTING TRUCK CROPS AND THE VEGETABLE GARDEN

It is difficult to sharply separate truck crops from field crops. It will be noticed that corn insects are treated in the preceding chapter on insects affecting field crops. Insects attacking onions, tobacco, turnips, and beets are likewise considered there. Irish potato and sweet potato insects are treated in the present chapter.

Potato Insects

The Colorado Potato Beetle.—This well-known beetle (*Leptinotarsa decemlineata* Say) and its larvæ are so familiar that they need no description. The adult beetles hibernate below the surface of the ground, appearing on the plants in the spring, soon after reaching the potato plants. They lay their eggs on the under sides of the leaves. These eggs hatch in something less than a week, the larvæ passing through four stages and requiring about three weeks to complete their growth. They pupate below the surface of the soil and occasionally upon the leaves. The pupal stage requires from one to two weeks. The egg-laying period lasts about five weeks, and the broods consequently overlap each other. We therefore find all stages upon the plant at the same time (Fig. 236). The female beetle lays from five hundred to one thousand eggs, these eggs being placed in masses of from nine to thirty-five eggs each.

It may be mentioned here that the so-called "old-fashioned potato beetle" (*Epicauta* sp.) sometimes occurs on potatoes.

Control.—The young larvæ can be killed by a spray of one pound of arsenate of lead in twenty-five gallons of water. As they get older, however, it is more difficult to poison them, and the adults are particularly resistant. Therefore, in order to make the poison more effective, it is advised to use one pound of Paris green, two pounds of arsenate of lead, and fifty gallons of water for all forms. Arsenate of lead is preferable to Paris green alone, since potato foliage is susceptible to injury. Several applications of the spray during the season may be necessary; it should be used

whenever the beetles are observed to be destructive. The old-time remedy of knocking the beetles into a pan in which there is a little kerosene is practicable for a few hills. In treating potatoes for fungous diseases and potato beetles at the same time, it is recommended that arsenate of lead be combined with commercial lime-sulfur diluted in volume to one part lime-sulfur in eighty parts of

FIG. 236.—The Colorado potato beetle, different stages; also two blister beetles. (Lugger.)

water, at the rate of two pounds of arsenate of lead to fifty gallons of the lime-sulfur solution. Or use one pound Paris green in twenty-five gallons of the Bordeaux mixture.

Potato beetles are subject to Tachinid parasites, and one or more bugs feed upon the larvæ. The quail and the rose-breasted grosbeak appear to be fond of this unpleasant insect.

The Garden Flea-beetle.—These small, shiny, black beetles (*Epitrix* sp.) are frequently seen upon potato vines and are hard to control. They attack not only potatoes but also tomatoes, egg-plants, beans, peas, clover, etc. Injury appears first as white spots on the upper sides of the leaves.

Control.—Plants thoroughly sprayed with arsenicals are apparently not injured as much as untreated plants, although this beetle is quite resistant to poisons. Air-slaked lime dusted on

Fig. 237.—External view of potato, showing work of potato-tuber moth. (After Chittenden, U. S. Bu. Ent.)

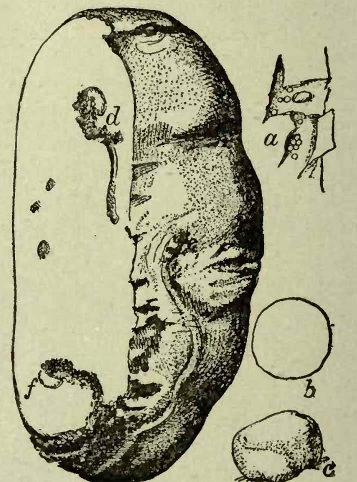


Fig. 238.—Details of work of potato-tuber moth: *a*, section of tuber, showing eye and eggs deposited about it; *b*, egg in outline; *c*, side view of egg; *d*, *f*, vines of larvæ in potato; *a*, natural size; *b*, *c*, greatly enlarged; *d*, somewhat reduced. (After Riley and Howard.)

infested plants we find to be quite effective. This flea-beetle hides on the under sides of the leaves, and one can knock many of them off into a pan in which there is a little kerosene by striking the plants with a brush or paddle. Bordeaux mixture is a good repellent. The plants should be sprayed with this when a few inches high.

The Potato Tuber Moth (*Phthorimæa operculella* Zell).—The adult is a grayish moth with a spread of wing of about one-half

inch. The female lays her eggs in leaves or stems, and the larvæ feed within the tissues, also boring into the tuber, where the most serious harm is caused. It is to be noted that this injury occurs both in the field, while the tubers are yet in the ground, and while they are in storage (Figs. 237 and 238).

Injury.—The quality and consequently the salability of the potato crop in some sections is at times seriously affected by this evidently introduced pest, particularly if the potato market in the early fall is slow, necessitating the holding of the tubers by growers. The insect occurs in California in abundance, in Washington, Texas and other southern and western states, and appears to be spreading northward. It is an enemy, but not a serious one, of tobacco also. (See tobacco insects.)

Control.—Hogs turned into an infested field after removal of the crop will consume practically all tubers left therein, with the contained larvæ. Infected potato plants, as well as weeds and all volunteer plants, should be burned. As in the case of many other insects, crop rotation is advised. Avoid having potatoes, tobacco, tomatoes, or egg-plants follow each other, since they are all host plants of this insect.

Stored potatoes, if infected, should be fumigated with hydrocyanic acid gas or bisulfid of carbon, using the latter at the rate of three pounds for every one thousand cubic feet of air space, and exposing to fumes in an air-tight house, or in bins, or in air-tight barrels for twenty to twenty-four hours. Use precautions against fire. This fumigation should be repeated two weeks later.

In fumigating with hydrocyanic acid gas the cubical content of building, room, or receptacle must be determined and the dosage based upon that. (See page 61.) An expert should be consulted.

CABBAGE INSECTS

The Imported Cabbage Worm.—The adult of this insect (*Pontia rapæ* Sch.) is the familiar white cabbage butterfly. The female has two black spots on each fore-wing—the male but one (Fig. 239, *a* and *b*). Both sexes have a black spot on the anterior margins of the hind-wings. The caterpillars are velvety green, about one or one and one-half inches long. They have a faint yellow stripe down the center of the back and a row of yellow spots on both sides.

Life History.—The butterflies are seen early in the spring and summer, flying over the fields and depositing their yellowish eggs

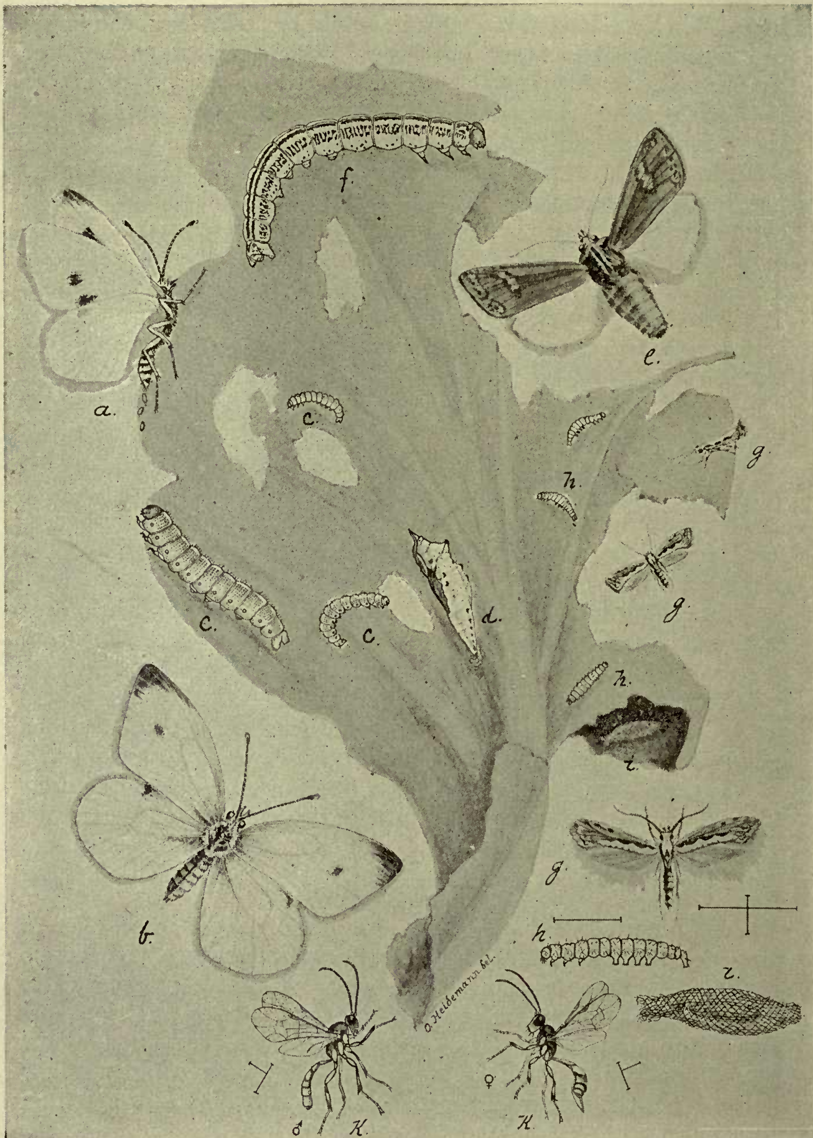


FIG. 239.—Stages of the imported cabbage butterfly, *a*, *b*, *c*, *d*; zebra caterpillar and moth, *e*, *f*; the cabbage plutella, *g*, *h*, *i*, *j*, and its parasite, *k*. (After Lugger.)

on the leaves of any food plant available. It requires about a week for the eggs to hatch, and the larvæ grow rapidly. It requires about two weeks for them to attain their full growth. They then transform into chrysalids, which are suspended by threads of silk from the leaves of food plants. The chrysalid changes from being greenish at first to a light brown. In one or two weeks the butterflies emerge. In the South there are from one to four or five broods each season. The last generation passes the winter in the chrysalid form among the old stalks and rubbish in the field.

Injury.—This insect eats large, irregular holes in the leaves of cabbage, cauliflower, and related plants, and disfigures the heads of cabbage and cauliflower by deposits of excrement.

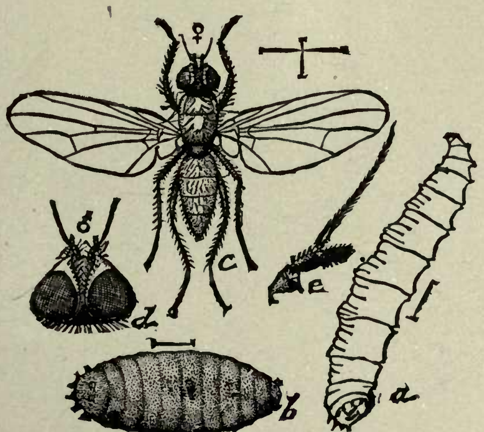


Fig. 240.—Cabbage maggot: *a*, larva; *b*, pupa; *c*, adult female; *d*, head of male; *e*, antennæ. Hair lines show actual sizes. (After Riley.)

Control.—Cabbages and cauliflower are not susceptible to injury by Paris green; hence, Paris green may be used upon cabbages for this insect as strong as four or five pounds to fifty gallons of water without any injury whatever to the plant. A little soap, however, should be added to the water to enable it to spread over the leaf; otherwise the spray runs off the leaf like water off of a duck's back. There is absolutely no danger to human beings on account of spraying cabbages. In the first place, little or none of the poison gets inside the head, and it has been demonstrated satisfactorily that a person would have to eat several bushels of sprayed cabbages at one sitting in order to obtain enough poison

to cause serious results. This is self-evident. Cauliflower, when not headed out, may be sprayed with Paris green. These worms may also be reached by the use of poison bran mash, such as is prepared for cut-worms. White hellebore may be used as a poison, if timid gardeners fear Paris green. As additional measures children may be hired at a nominal sum to pick the caterpillars from the plants or to catch the white butterflies over a cabbage field. This pest is extensively parasitized.

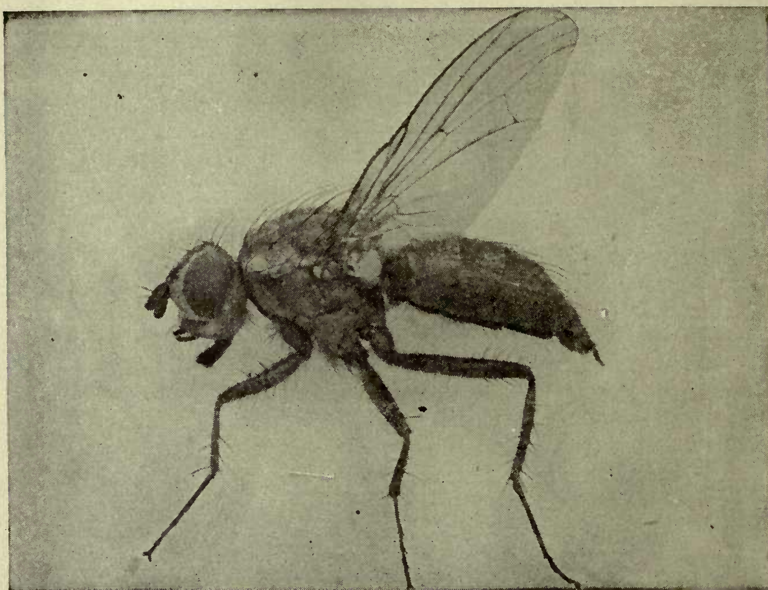


FIG. 241.—Female cabbage maggot fly, much enlarged. (After Slingerland.)

Figure 239 also illustrates the zebra caterpillar and its moth, and the cabbage plutella and parasite.

The Cabbage Maggot.—The adult insect is a small fly (*Pegomyia brassicæ* Bouche) resembling the house-fly, but it is smaller.

Life History.—Eggs are laid abundantly during the spring, either upon the stalk or upon the ground close to the crown of the plant or upon the roots just below the surface of the ground —one egg being generally laid in a place. One fly deposits a large number of eggs, flying from one plant to another. The egg stage lasts from three to five days, and the life of the maggot is of about

three weeks' duration. The larval skin hardens at the end of that period, and the insect pupates either close to the stalk or two inches away. This stage lasts about two weeks. The fly has two or more broods (Figs. 240 and 241).

It attacks the cabbage and cauliflower, also turnips and radishes, but cauliflower is its preferred food. The maggot tunnels in the roots of the plants, causing those attacked (Fig. 242) to wilt and usually to die.

Control.—Clean cultivation is helpful. Crop rotation is desirable. Cabbages and cauliflower in a breezy location are not so

Fig. 242.—A cabbage plant wilted down, as result of attacks of cabbage maggot.

liable to suffer as those sheltered from the breeze. Plants in sandy soil appear to suffer most. Seed beds in cold frames invite attacks of the fly, and young plants are often affected when transplanted; cold frames containing the cabbage or cauliflower plants should therefore be covered with screens in order to prevent the entrance of the fly. Old cabbage or cauliflower stalks should not be permitted to remain in the field over winter. Tarred paper disks are in some localities placed around the crown of the plant when it is set out, but these are not always practicable or effective (Fig. 243). Since the adult flies are, like the house-fly, attracted to sweet substances, recent experiments indicate that plants may be sprayed with a sweetened poisoned liquid, thus destroying them

before many of them have laid their eggs. Two different recipes for this poison spray are as follows:

(*a*) 3 ounces arsenate of lead, 2½ pounds brown sugar, 4 gallons water.
(*b*) 1/5 ounce arsenite of soda, ½ pint cheap molasses, 1 gallon water.

It is not necessary to spray *all* the plants in a field. If an occasional row is treated, sufficient attraction is offered. Late planted cabbages are not so seriously affected as are early cabbages: Holland cabbage appears to be exempt. Applications to the roots are rarely very effective.

The Cabbage Aphis or Cabbage Louse.—On the under side of the leaves of cabbage and other members of the mustard family

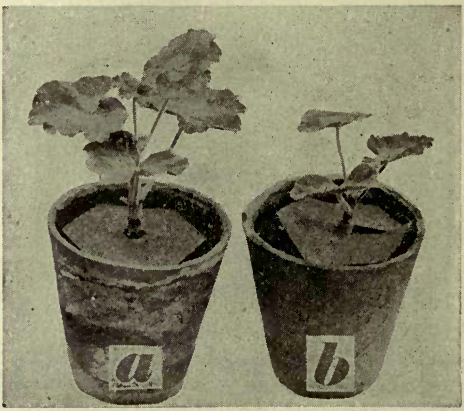


FIG. 243.—Tarred paper disks applied to plants: *a*, correctly applied; *b*, incorrectly.

are frequently found, in summer, large colonies of these lice (*Aphis brassicæ* Linn.). They are yellowish. Winged individuals appear from time to time and fly from one plant to another. The average length of life of each generation is about twelve days, and each wingless female gives birth to about forty young. In the fall winged males and females appear which mate and thus produce eggs for the next season's generations.

Injury.—Plants are weakened by a constant drain upon the sap and are thus made unfit for use, even if they reach a marketable age.

Control.—Practice clean cultivation and the destruction of all refuse of the year's crop in the fall. The curling of leaves protects the lice and prevents successful spraying, for any spray used must

actually strike each aphid in order to destroy it. Wild mustard and shepherd's purse in the field should be destroyed. Young plants in the seed bed are often infested before transplanting; hence the necessity, as in the case of the cabbage maggot, for screening the cold frames with fine screens or cheesecloth. Young plants, if infested, may be dipped at their tips in a weak solution of soap in order to destroy the lice upon the leaves. If spraying is resorted to, nicotine sulfate may be used at the rate of one part of the extract to sixty-four parts of water. Or use whale-oil soap at the rate of one pound to six gallons of water. Or use any laundry soap at the rate of one pound to three gallons of water. These lice, like other species, are subject to extensive attacks by parasites.

The Harlequin Cabbage Bug (*Murgantia histrionica* Hahn).—This is a shiny black or deep blue insect with brilliant red or orange markings. It is about one-half inch long and is more or less flattened. It is sometimes called "terrapin bug" on account of its shape and markings. The young bugs resemble the older ones closely, but have no wings (Fig. 244). These bugs will probably never be very injurious in the northern tier of states, since they are particularly a southern pest.

Life History.—They feed on any of the mustard family of plants, but prefer cabbage. The adults live over winter in old cabbage stumps and in weeds and rubbish left on the field, and emerge in the spring. Eggs are laid on kale or wild mustard or other wild plants of the mustard family to which cabbage, radishes, and turnips belong. There are three or more broods.

Control.—When once established, they are difficult to combat. Old stalks and leaves should be cleared up to remove from the field hibernating quarters. A few piles of brush may be left to attract the adults in the fall that they may be destroyed. A trap crop of kale or mustard may be planted early in rows through the field that is intended for cabbage. The bugs prefer kale to cabbage, and these trap rows can be sprayed when covered with bugs, using pure kerosene. The nymphs or young bugs may be killed with a whale-oil soap solution. Use one and one-half or two pounds of soap to a gallon of water; or use one part stock solution of kerosene emulsion in six parts of water. Sprays, however, are not to be depended upon in this connection. The importance of killing the hibernating brood cannot be too strongly emphasized.

The Striped Flea-beetle (*Phyllotreta vittata* Fab.).—This is a striking insect, one-tenth of an inch long or less. It is black,

with a broad, wavy, yellowish stripe on each wing-cover. Like other flea-beetles, it is very active and is hard to catch. The larval form is found in the roots of young cabbage plants. The female lays her eggs in openings in the root of the cabbage or other cruciferous plants, near the crown. When the larva is mature it transforms into an earthen cocoon close to the plant, and in a few days the beetle emerges.

Injury.—While the beetle eats the leaves of turnips, cabbages, etc., and is sometimes found on strawberries, its chief injury, perhaps, is inflicted through mining into cabbages, turnips, and radishes. It may occur in such numbers as to become a serious pest, causing considerable injury.

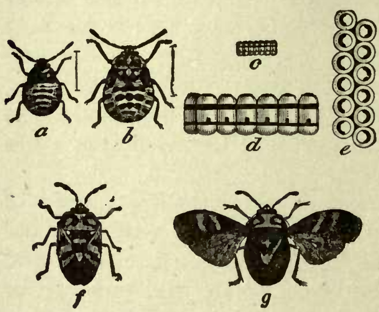


Fig. 244.—The harlequin cabbage bug, different stages. (After Riley, U. S. Bu. Ent.)

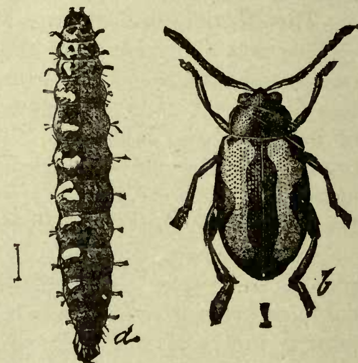


Fig. 245.—The striped flea-beetle. (U. S. Bu. Ent.)

Control.—The adults may be controlled by dusting with hellebore. It is also advisable to dust with air-slaked lime, soot, or ashes on foliage when beetles are present. The beetle and grub are shown in figure 245.

The Zebra Caterpillar (*Mamestra picta* Harr.).—This caterpillar is conspicuous on account of its striking colors. When full grown it is two inches or more in length. The body is yellow, with a black stripe down the back and another down each side. The head is red. The first generation feeds in early summer and the second in the fall. The species hibernates in the pupal stage.

It attacks cabbage, spinach, celery, and peas.

Control.—Hand-picking is the usual remedy, but it may be controlled by spraying with strong solutions of arsenate of lead or Paris green (Fig. 239, *f*). (See, also, colored plate.)

The Diamond-back Moth (*Plutella maculipennis* Curtis).—This is the insect whose caterpillar riddles cabbage leaves with small holes. It is found upon the plants along with the green cabbage worm. The moth which lays eggs producing these caterpillars is yellowish above, and its wings, which are kept folded, are turned up slightly at the tips. The wings also bear a long fringe. The lower part of the folded wings is bronze brown. The caterpillar is one-third of an inch long and pale green in color. It tapers toward each end, and is quite active. These caterpillars pupate in small cocoons of delicate silk lace-work, and the brownish pupa may be seen through the thin walls of the cocoon (Fig. 239). In winter-time the cocoons are to be seen on old cabbage stalks in the field or on stored cabbages.

Control.—The remedies advised for the green cabbage worm also control this pest.

INSECTS ATTACKING CUCUMBERS, MELONS AND RELATED PLANTS

The Striped Cucumber Beetle.—This insect is destructive in both the larval and adult stages. The beetle (*Diabrotica vittata* Fab.) is slightly less than one-half of an inch in length, and is

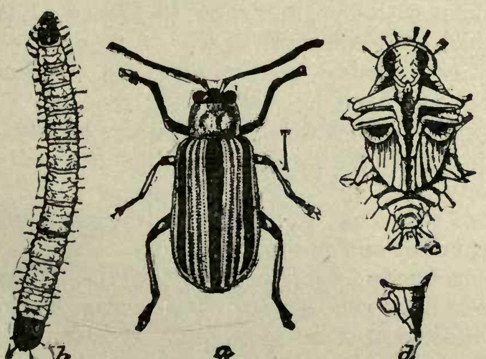


FIG. 246.—The striped cucumber beetle. (U. S. Bu. Ent.)

black with yellow stripes (Fig. 246). It lays its yellowish eggs in clusters upon the root of the plant, and the grub feeds on the root within the ground. The pupal period is passed in the soil, and the adults winter in rubbish and waste in the fields. Frequently one finds small mites upon these beetles, but evidently the mites use the beetles as a means of transportation, and it is doubtful whether they appreciably reduce their numbers.

Injury.—The adults feeding on plants opens the way for infection by fungous diseases. The presence of the larvæ on the roots or in the stems is shown by the wilting of the plant. Both cucumbers and melons are attacked.

Control.—Two tablespoonfuls of tobacco extract in one gallon of water, poured about each plant at the rate of a cupful to each hill, is excellent if done any time before the plant is seriously weakened by the larvæ. This, as applied, costs from forty to sixty cents for each one hundred gallons. It should be done every four or five days, at the first appearance of the beetles. The application acts also as a stimulant for the plants. It is also advisable to protect young cucumbers and melons as soon as up with inexpensive covers of cheesecloth placed over the plants in such a way as to prevent the attacks of the adult beetles. These net covers should be used as long as possible, that the plants may have a good start.

Some planters sow the seed in rows rather thickly, and thin after the worst damage is over. The planting of an excess of seed, afterward thinning, is common practice. Air-slaked lime dusted on the young plants is excellent. This should be done while the leaves are moist with dew, and should be repeated as often as the dust is washed off. Arsenate of lead, four or five pounds to a barrel of water, affords a good spray. All old vines should be gathered and destroyed as soon as the crop is off the ground. This also applies to all refuse. The beetles are thus deprived of food and hibernating quarters, and this indirectly causes the death of many.

The above remedies are applicable to melons and cucumbers as well as squashes and pumpkins.

The Melon Louse (*Aphis gossypii* Glov.).—The wingless form of this louse is light yellowish or olive or even black in color. It is about one-fifteenth of an inch long. It is found on the under surface of leaves, which it causes to curl (Fig. 247). Tender-growing shoots are favorite points of attack. Winged individuals are developed whenever the lice are compelled, from lack of food or removal of crop, to seek new feeding grounds.

Control.—Detect infested plants early and destroy them. Spray under the surface of leaves with tobacco extract. Fumigate with nicofume paper, using one sheet to a plant, in an enclosed space. Or fumigate with bisulfid of carbon, using one teaspoonful to each cubic foot of space. Plants may be enclosed within a

light frame covered with oiled muslin. The under side of leaves may be dusted with pyrethrum powder.

The Cucumber Flea-beetle (*Epitrix cucumeris* Harr.).—These tiny beetles occur throughout the United States and are found upon tomatoes and potatoes, as well as cucumbers, melons, and allied plants. When found in potatoes, the grubs mine in the

Fig. 247.—Melon leaves curled by attacks of lice. (Chittenden, U. S. Bu. Ent.)

tubers. The principal injury is done to the foliage by the young beetles, just after it is up in the spring. The leaves are riddled. A badly riddled leaf appears as if hit by a charge of bird shot, though sometimes the surface is eaten off at each feeding place. The beetles are black, one-sixteenth of an inch long (Fig. 248). They hibernate over winter in leaves and rubbish, and emerge

in the spring and lay eggs on the roots of common weeds of the nightshade family. The larvæ of this brood live in the roots of these plants and later transform to beetles and attack foliage.

Control.—Bordeaux mixture, combined with Paris green, or lime-sulfur combined with arsenate of lead, are perhaps the best sprays, acting as repellents, largely. Dusting with air-slaked lime is helpful.

The Twelve-spotted Diabrotica or Southern Corn-root Worm.—These yellowish-green beetles (*Diabrotica 12-punctata* Oliv.), with twelve black spots on the back and a black head, are practically omnivorous. They feed on a large variety of foliage and flowers, of forage and garden crops.

Injury.—The larvæ or grubs feed upon the roots of melons, cucumbers and allied plants. Plants frequently die as a result of attack upon their roots. In the South this is known as the "Southern Corn-root Worm," and it attacks the stalk of corn just above the roots. If it eats to the center of the stalk the "bud" will die; hence it is locally known as the "bud worm" (see page 208).

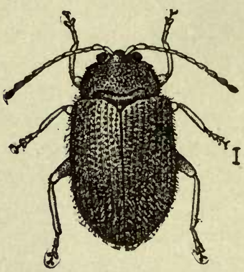


FIG. 248. — The cucumber flea-beetle. (U. S. Bu. Ent.)

Life History.—There are two generations. The beetles are among the first insects to appear in the spring, and their life cycle, from egg to adult, occupies from six to nine weeks. They may be seen on clover or alfalfa in the late fall. Figure 249 illustrates the species.

Control measures are the same as for the striped cucumber beetle.

The Neat Cucumber Moth or Pickle Worm.—This worm, the larva of a yellowish-brown moth (*Diaphania nitidalis* Cramer), is three-fourths of an inch long. It is greenish or yellowish green in color, with a brown head. The larva bores into the stems and leaves of the cucumber. It takes about two weeks for a caterpillar to attain its full growth; it then spins a thin silken cocoon in a fold of the leaf. The pupal stage requires about a week, and the complete cycle lasts from three to four weeks in midsummer. The winter is passed in the pupal stage, either in the old vine left on the field or in other trash.

Injury.—The larvæ hatching from eggs laid on the blossoms usually feed in the blossoms, and six or more may be found in a single squash blossom at one time. Older caterpillars bore into

the fruit itself. This injury to the fruit causes decay. In some localities this insect is a serious pest to cucumbers, squashes, and melons. It destroys the blossoms, mines the stems, and bores into the ripening fruit.

Control.—Since the injury is worse in late summer, it is advisable to plant early and also to grow early maturing varieties of the vegetables which this worm seeks. All litter on the field, including old vines, should be destroyed after harvest. Since these pests prefer to lay eggs on the squash, this plant may be used as

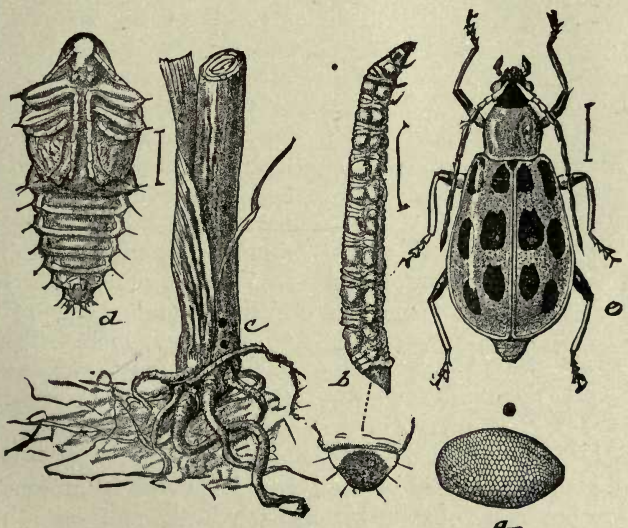


FIG. 249.—The 12-spotted Diabrotica, different stages, details of structure and injury. Hair lines indicate actual size. (U. S. Bu. Ent.)

a trap crop, if melons or cucumbers are to be protected. For example, one might plant rows of summer squash through cucumber or melon fields at an early date, planting every two weeks, so that some would be in flower during July. The flowers could be collected and destroyed with the contained larvæ at frequent intervals. This method of control has been carefully tested and found to give almost complete protection to muskmelons. Arsenical sprays are of little value. When possible, change the location of plants each year. Collect and destroy badly infested fruit whenever it is observed.

The Squash Bug (*Anasa tristis* DeG.).—The adult bug is a

rich brown or black insect, five-eighths of an inch long. It has a strong sucking beak and a small head. This insect attacks cucumbers, melons and squashes, and is well known to most of our gardeners (Fig. 250). The young, or nymphs, are grayish to black, and cluster in colonies. The orange or red eggs are laid in batches on the under side of the leaf. The adults hibernate over winter in the old vines. One brood is hatched in the northern states and two or three in the southern. The insect appears as soon as the vines are up. The eggs hatch in a few days after being laid. As a result of the attacks of the squash bug leaves curl, turn brown, and die.

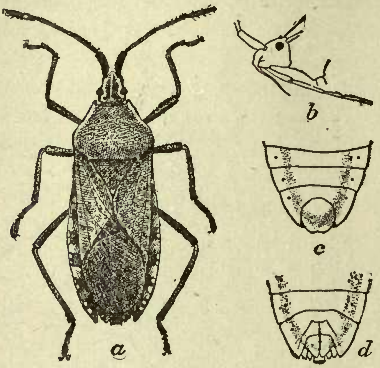


FIG. 250.—The squash bug; *a*, mature female; *b*, side view of head and beak; *c*, abdominal segments of male; *d*, same of female; *a*, twice natural size. (After Chittenden, U. S. Bu. Ent.)

Control.—The egg masses may be destroyed. The young nymphs may be killed with kerosene emulsion. Use one part of the stock emulsion diluted with nine parts of water by volume. The adults may be trapped under bits of board where they hide. The vines should be destroyed as soon as the crop is off the ground, in order to kill the bugs not yet matured. Any contact spray is effective for adults. Growers should plant an excess of seed, and it is wise to protect young plants by coverings of some sort. Early in the morning, while still cool, the adults are more or less sluggish and may be hand-picked.

The Horned Squash Bug (*Anasa armigera* Say) calls for the same measures of control. It is similar in general appearance and habits to the species above discussed.

INSECTS AFFECTING BEANS AND PEAS

Bean Aphids.—These small black plant lice (*Aphis rumicis* Linn.) may be observed crowded together in clusters on the tender tips of bean stalks and on the under side of the leaves. They also attack dahlias, dock, shepherd's purse, pigweed, snowball, etc. Winged forms appear during the season. Eggs are laid in the fall around buds of certain weeds and shrubs. In the spring the first generations multiply upon these plants and then separate to other

common weeds, migrating in May or June to beans. Aphids multiply during summer by giving birth to living young.

Control.—The usual remedies applicable to other plant lice

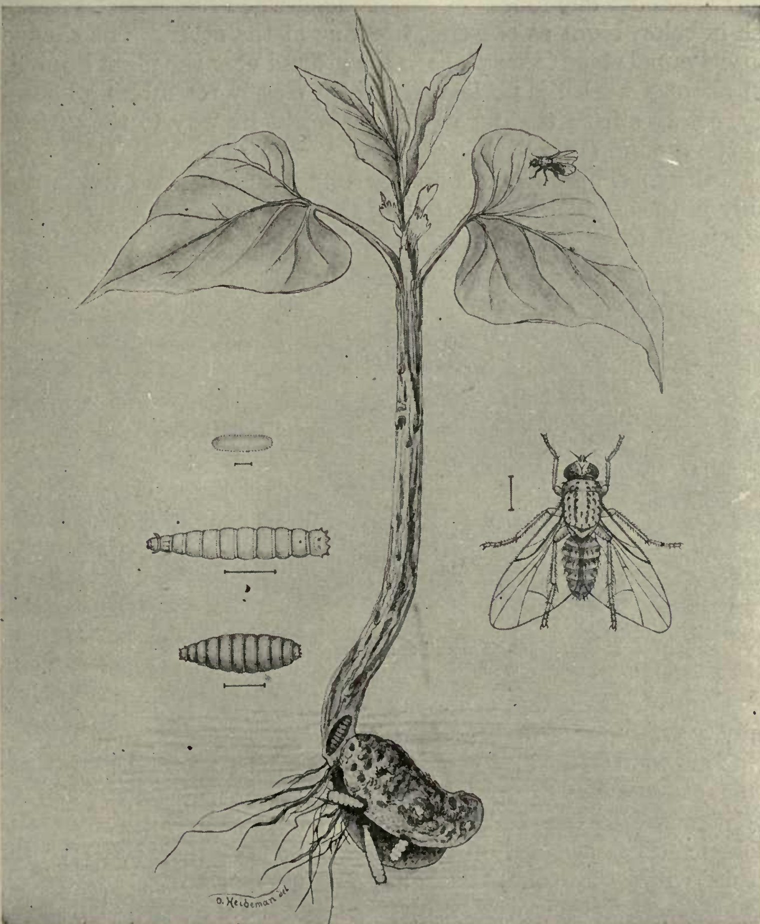


FIG. 251.—The bean maggot fly, different stages, and its work. (After Lugger.)

may be used here if necessary. Whale-oil soap, one pound to five or six gallons, is probably safer than kerosene emulsion or laundry soap in the same proportion. One or two tablespoonfuls of nicotine sulfate in a gallon of water is an excellent and effective

spray for all lice. It should be used, if possible, in a way to hit the insects.

The Bean Maggot or Bean Fly.—These maggots (*Pegomya sp.*) are about one-fourth of an inch long when full grown, yellowish in color, blunt at one end, tapering at the other. The change to the pupal stage takes place in the ground near the plant injured. In about a week the perfect fly, which closely resembles a house-fly, emerges from the puparium and works its way to the surface of the ground (Fig. 251).

Injury.—This maggot bores in planted beans, and works not only in the seed but in the stem of the growing plant as well, thus causing it to wither and die.

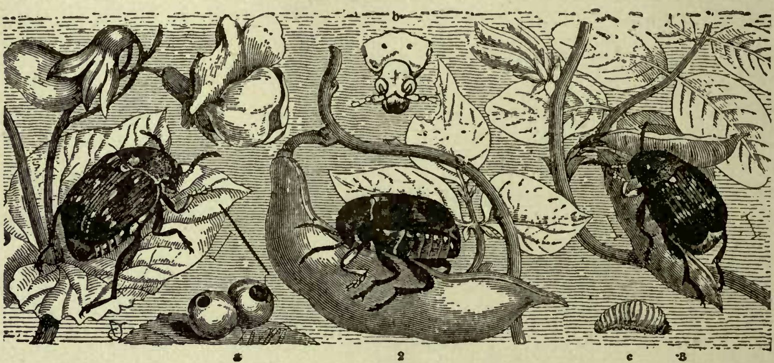


FIG. 252.—Bean weevil and pea weevil. (After Brehm.)

Control.—Rotation of crops and fall plowing appear to be the only available remedial measures.

The Bean Weevil.—This is a small robust snout beetle (*Bruchus obtectus* Say), brownish gray in color, with head bent at right angles to body. The wing-covers are shorter than the abdomen. Eggs are laid on the growing pods in the field, and the grubs enter the young beans, sometimes several in one bean. They continue their work in dry beans, rendering the same unfit for seed. This insect also attacks peas and occasionally other seeds.

Control.—Infested seeds, for the most part, float on the water, while sound seeds sink. This affords a means of separating good from bad seed. A still better method is fumigation of the seed with bisulfid of carbon. Place the seed in a tight receptacle,

pour the liquid upon it, and keep the receptacle closed for one or two days. No flame should be brought into the vicinity of bisulfid of carbon. A tablespoonful of the liquid used in a two-quart jar full of seed is effective if the jar is closed tightly.

Figure 252 illustrates both the bean weevil and the pea weevil.

The Pea Weevil (*Bruchus pisorum* L.).—This beetle is similar in general appearance and habits to the bean weevil. In color it is blackish, covered with soft brown hairs, and its back is marked with black and white. The adults appear in the field at blossoming time. The yellow eggs are laid on the pea pods, and the grub bores through into the seed. If undisturbed, the adult may remain in the seed until spring. The same remedies as given for the bean weevil are applicable to this insect (Fig. 252).

The Pea Aphis.—This is a large green louse (*Macrosiphum pisi* Kalt.) attacking peas. It has many natural enemies in the shape of parasites and predaceous insects. Since it passes the winter on clover, it is suggested that peas, if possible, be not planted near clover. Otherwise control measures are practically the same as for the bean aphis.

The blister beetles (page 198), so-called "old-fashioned potato bug," occasionally attack beans and may cause serious injury locally.

INSECTS AFFECTING RADISHES

Flea beetles of various species may justly be regarded as enemies of radishes. Their attacks may be controlled to some extent in the garden by the use of air-slaked lime or ashes.

Cabbage Maggot.—The chief pest of the radish is the cabbage maggot, which tunnels in the roots. This insect has been described under Cabbage. The writer has secured immunity for his radishes by using a decoction of tobacco stems, and more recently by using nicotine sulfate solution, at the rate of two tablespoonfuls to a gallon of water. This solution is poured along the rows of plants when they are about an inch or two high, and is repeated once in every five or six days until the radishes are nearly fit for table use. Early-sown radishes are not so liable to attack as later crops. Radishes, when young, may also be treated with the poisonous spray recommended for the cabbage maggot.

The Asparagus Beetle.—This destructive insect (*Crioceris asparagi* Linn.) is one-fourth of an inch long. It is of a general bluish-black color, with yellowish wing-covers, marked on the

edges with dark blue. The thorax is red. The beetle is quite active and shifts its position around the stem when disturbed. The larva or grub is one-third of an inch long, grayish or olive in color, with a shining black head. The winter is passed in the adult stage. The beetle emerges about the time that the asparagus shoots are ready for cutting. Later, eggs are laid on these shoots and on the older stems of the plant.

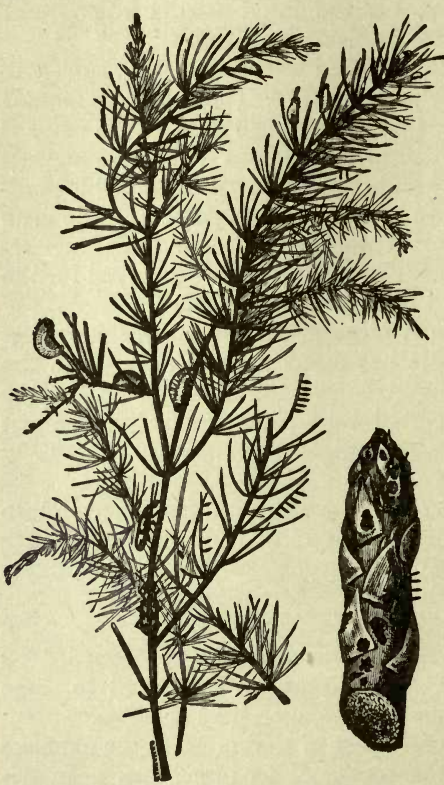


FIG. 253.—The asparagus beetle and injury caused thereby. (U. S. Bu. Ent.)

Injury.—The young shoots and leafy tips of the asparagus are attacked by both larva and adult (Fig. 253). The shoots are rendered unfit for use, and the injury to the tips weakens the plants.

Control.—Where this pest is injurious, one may obtain some relief by allowing a few stalks to grow up in the early spring and then poisoning them with Paris green or arsenate of lead. Air-slaked lime dusted on the larvæ will kill them. Shoots should be frequently cut for table or market.

INSECTS INJURING CELERY, PARSNIPS, CARROTS

The tarnished plant bug attacks plants of this group (see page 84). The celery tree hopper attacks celery. Remedies for this insect are similar to those given for the grape-vine leaf-hopper (see page 164). Besides the three insects treated under this head, others affecting these crops are the parsnip web-worm and the parsnip leaf miner.

The Carrot Beetle.—This is a brown scarabid beetle (*Ligyrus gibbosus* DeG.), a little more than one-half an inch long. It works upon carrots, celery, and parsnips, and also attacks corn, potatoes, and other crops. Adults are found attacking the crown or root of the plant below the surface. They are sometimes present in large numbers in a field of root crops. The work may be nearly destroyed without injuring the top of the plant. The larvæ resemble in miniature the familiar "white grub."

Control.—Rotation of crops and fall plowing are the standard remedies. Hogs and chickens allowed to run in the infested field after the removal of the crop will lessen their numbers materially. Some success has been attained in combating other members of this family (*Lachnosterna* and allied genera) by the use of a lantern trap, to which they are attracted, early in the season before egg-laying begins. Manifestly such traps would be of little service after that period.

The Celery Caterpillar.—The adult of this insect is the common black, swallow-tailed butterfly (*Papilio polyxenes* Fab.). The caterpillar itself is green or yellow, with black stripes, having retractile yellow horns placed a short distance back of the head. These horns are extended when the caterpillar is disturbed. In the northern states the winter is passed in the chrysalid (pupal) stage, the butterflies appearing in May. Eggs are laid on the foliage and hatch in from four to nine days. The young caterpillars are nearly black, with a white band around the middle of the body. The complete life cycle requires about eight weeks.

The caterpillars feed on the foliage and undeveloped seed of almost all umbelliferous plants, including celery, parsnip, caraway, parsley, fennel, dill, and wild carrot, wild parsnip, as well as the garden carrot.

Control.—Hand-picking is often all that is necessary. Spraying or dusting with arsenicals may be best for large areas if the insects are very numerous.

The Carrot Rust Fly (*Psila rosæ* Fab.).—Celery leaves sometimes turn a reddish color, due to the attacks of this small insect, which belongs to the order *Diptera*, or two-winged flies. The roots are also discolored by the maggot which is often found in the roots of carrots. Clean cultivation after cropping is recommended, as well as rotation of crops. Celery should not follow carrots.

Other Enemies of Celery.—Wire worms of several species sometimes injure celery, as does also the tarnished plant bug.

INSECTS AFFECTING TOMATO

Refer to tobacco insects in the chapter of field crop insects, as several of the tobacco insects also attack the tomato. See also treatment of the corn ear-worm, pages 210 and 218.

The Stalk Borer.—More than one species of this genus of moth (*Papaipema sp.*) probably bores in the stalks of tomato, as well as in dahlias, lilies, and other garden plants. Its eggs are laid in the fall of the year on various weeds about the garden; the larvæ hatch in the spring, and first feed as leaf miners and then burrow into the stalk of the plant upon which they were hatched. They may migrate to other cultivated plants. They pupate in the lower part of the stalk.

Control.—Since the eggs of these insects are laid by the moths at the base of weeds, all weeds in the garden and in the vicinity should be destroyed late in the fall by burning. Further, the entire stock of weeds should be burned and not merely the tops. When a tomato plant is infested, it is shown by a drooping of the affected part of the plant. The affected shoot, if small, may be cut off, and the borer destroyed. If the worm is in a larger stem, a few teaspoonfuls of bisulfid of carbon may be injected into the opening with a medicine dropper and the hole plugged with cotton, wool, or soil to confine the gas. Too much bisulfid of carbon should not be used on account of danger of injury to the plant stem.

See also Chapter XIV, page 256.

INSECTS ATTACKING GINSENG

Ginseng is attacked by white grubs, and the reader is advised to turn to the description of this pest, and study methods of preventing injuries. (See page 135.)

RHUBARB INSECTS

A plant of such rapid, vigorous growth as the rhubarb is naturally more or less exempt from injury on the part of insects. As a matter of fact, the rhubarb curculio is its most serious enemy.

The Rhubarb Curculio.—This reddish-brown snout beetle (*Lixus concavus* Say) is about three-quarters of an inch long. It injures the plant by making food punctures in the leaf stem and sometimes in the leaves. Eggs are deposited in the stems of rhubarb or in dock. The size and color of these insects make them fairly conspicuous, and they may be hand-picked from rhubarb and the weed above mentioned.

The Rhubarb Flea Beetle.—This greenish flea beetle (*Psylliodes punctulata* Mels.) exhibits a preference for rhubarb, but it is also found on other vegetables. Its presence is recognized either by holes in the leaves or by brownish-yellow spots on the leaves. When necessary, one may resort to the usual remedies for flea beetles. (See page 228.)

INSECTS AFFECTING SWEET POTATOES

The sweet potato in most districts is quite free from insect attacks, as compared to many other truck crops. The sweet potato borer is perhaps the most injurious of the eight or ten pests which are found attacking these plants.

The Sweet Potato Root-borer or Weevil.—This snout beetle (*Cylas formicarius* Oliv.) is known to occur in China, India, Australia, Madagascar, Jamaica, and Cuba. It was probably first imported into this country from Cuba in shipments into Louisiana.

It is a slender beetle, one-quarter of an inch long. It somewhat resembles an ant. The general color is bluish black, with the pro-thorax brown.

Injury.—The female eats cavities into the potatoes or into the vine at its base and deposits its eggs therein. The young larvæ at first bore into the vine and later into the tubers. The pupal stage is passed within the tuber. Evidently this insect may continue to increase and cause injury even after the potatoes are stored.

Control.—No treatment is available while tubers are in the ground. Badly infested potatoes may be fed to hogs and the vines burned. Growers who receive potatoes from infested localities should fumigate them before planting. Use either bisulfid of carbon or hydrocyanic acid gas. (See page 61.)

Tortoise Beetles and "Golden Bugs."—Several species of these insects, members of the family *Cassidæ*, are fond of the foliage of the sweet potato. Of these, a very common form is the golden tortoise beetle (*Coptocycla bicolor* Fab.), the common name of which indicates its color. The black-legged tortoise beetle (*Cassida nigripes* Oliv.), however, is the largest of this group and the most injurious. The mottled tortoise beetle (*Coptocycla signifer* Feb.) is another member of this family affecting the sweet potato. Another is the two-striped sweet potato beetle (*Cassida bivitata* Say).

Description and Life History.—All tortoise beetles have approximately identical life histories. The adults resemble somewhat minute tortoises in shape. They originally fed upon weeds, particularly wild morning glories. The taste for cultivated plants is an acquired one. The leaves of the young sweet potato plants are attacked, and frequently the entire plants are ruined, requiring resetting. The eggs are laid on the stems and leaves. The larvæ are less injurious than the adults. They are short, bristling creatures, with the disgusting habit of heaping their excrement on the top of their bodies by means of fork-like appendages on the posterior ends of the abdomen until they are nearly or quite covered and concealed from view. The pupal stage is passed upon the leaves, and the beetles hibernate in the adult stage.

Control.—Dip young plants in a solution of one pound of arsenate of lead in ten gallons of water just before they are set out. This is perhaps the most efficacious means of control. A pint of molasses added to this makes it adhere better to the plants. This material may be sprayed upon the plants when they are first attacked.

Cut worms.—These pests cut the young and tender plants shortly after they are set. They are controlled either by the use of poisoned bran mash, described on page 195, or by dipping the plants in arsenate of lead and water at the time of planting, as advised for the tortoise beetles. In case of severe attacks both measures might be advisable.

Flea Beetles.—One or more species of this sort attack young sweet potato slips. One should use the same remedies as advised for tortoise beetles. (See page 249.)

Saw Flies.—The larvæ of these insects are the small slimy "slugs." They are not to be confounded with the true slugs or naked snails, which are mollusks. Two species are known to attack sweet potatoes and feed upon their leaves. Plants coated with arsenate of lead, as previously suggested, would be immune to attacks by this insect.

Other insects which may attack sweet potatoes are sweet potato plume moth, the cucumber flea beetle, the sweet potato hawk moth, and, occasionally, crickets.

PEPPER PLANT INSECTS

The Pepper Weevil.—This insect (*Anthonomus æneotinidus*), quite injurious in Texas, was originally introduced into this coun-

try from Mexico. It works in the pepper pod, causing distortion and rendering it unfit for food. It is in part controlled by gathering and destroying infected peppers which fall to the ground.

EGG PLANT INSECTS

Three enemies of egg plants have already been described under other heads. For the aphis, see melon aphis, page 238. For the potato tuber moth, see page 228; see also tobacco insects where it is referred to as "split worm." Potato beetles attack egg plants (see page 226). Flea beetles are often very serious enemies of egg plants. These are described among the potato insects.

INSECTS ATTACKING OKRA

Plant lice, leaf-eating caterpillars, leaf-hoppers, and a few other forms affect this plant, but not seriously.

QUESTIONS

1. Give life history of the Colorado potato beetle.
2. What is the best insecticide for this beetle, and how applied?
3. What is the best treatment for flea beetles on potatoes?
4. Discuss the potato tuber moth and give remedial measures.
5. Give life history of the corn ear-worm.
6. Give description, life history, and remedies for the imported cabbage worm.
7. Why is soap used in the spray?
8. What injury is caused by the cabbage maggot? Describe its work. What crops are affected?
9. What are the best measures of control?
10. How should a cabbage grower treat a five- or ten-acre field badly affected with cabbage aphis?
11. Give life history of and control measures for the striped cucumber beetle in both larval and adult forms.
12. Give treatment for melon lice.
13. Give description and life history of the southern corn root-worm.
14. Enumerate the injuries caused by this insect and state treatment advised.
15. Give description, life history of, and control measures for the common squash bug.
16. How should we treat seed beans or seed peas if infested with weevils?
17. Give life history of the asparagus beetle.
18. Enumerate the insects attacking celery, parsnips and carrots.
19. Give remedial measures in each case.
20. How is the stalk borer combated when attacking tomatoes?
21. Enumerate the insects which attack sweet potatoes.
22. Give remedies in each case.
23. What insects attack the pepper plant and how combated?
24. What radical difference is to be noted between the treatment of the Colorado potato beetle and melon lice? Why?
25. Give accounts of damage from insects in gardens in your section.

CHAPTER XIV

INSECT ENEMIES OF THE GREENHOUSE AND HOUSE PLANTS, AND OF THE FLOWER GARDEN

THE growers of flowers for home adornment, as well as the commercial florist, often make use of a greenhouse conservatory or of other indoor places for plants a part of the year. A number of insect enemies cause much trouble to these plants, either indoors or outside. In this chapter such enemies are divided into two groups: (1) those most troublesome inside, and (2) enemies of the flower garden.

INSECTS OF THE GREENHOUSE AND ON HOUSE PLANTS

Among the insects found in greenhouses occur one or more species of mealy bug, greedy scale, rose scale, white fly, greenhouse leaf roller, "red spider," and various aphids or plant lice. Last, but by no means least, are sow bugs or wood lice. These are Crustaceans and not insects.

The Destructive Mealy Bug.—These insects belong to the scale family, but, unlike most others in this group, can move about when adult. A mealy bug of this species (*Dactylopius destructor* Comst.) is one-eighth of an inch long and one-twelfth of an inch wide. It is brownish yellow below, and white with an indication of a median line above. A powdery secretion covers the surface of the body. The segments of the body are quite distinct and a number of filaments are borne on the sides (Fig. 254). The male has two transparent wings, and has a wing expanse of less than an eighth of an inch. The body is dark brown and the eyes dark red.

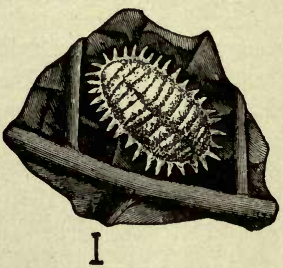


FIG. 254.—The destructive mealy bug. (After Comstock.)

Life History.—The female begins to lay eggs before she is fully grown. The eggs are attached in a cottony mass at the posterior end of the abdomen. This egg mass increases with her growth. Since the end of the body is forced upward by the increased mass of eggs, the insect finally appears to be almost stand-

ing on her head. When the young hatch they spread in all directions over the plant, generally settling along the midrib or on the under side of the leaves, or in the forks of the young twigs. They form closely packed colonies at first, and at this stage there is only a slight covering of the powdery secretion referred to above.

Injury.—The mealy bug is a very troublesome pest in greenhouses, for it attacks almost all plants. However, when the greenhouses are fumigated at regular intervals, these insects are rarely troublesome.

Control.—Nicotine sulfate or whale-oil soap may be used. If only a small number of plants are to be treated, the pyrethrum decoction is to be recommended.

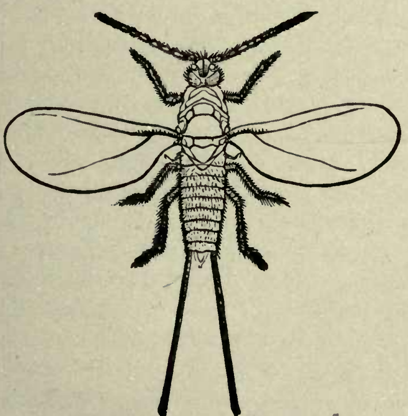


Fig. 255.—The mealy bug with long threads, male. (After Comstock.)

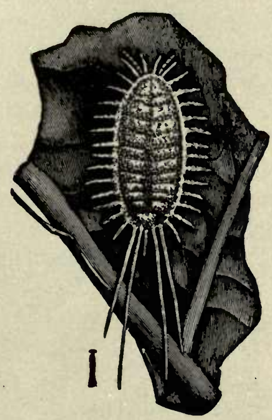


Fig. 256.—The mealy bug with long threads, female. (After Comstock.)

The Mealy Bug with Long Threads (*Dactylopius longifilis* Comst.).—This insect resembles the previous pest very closely except in technical details. The lateral filaments are seventeen in number and are quite long, and the last on each side is equal to or longer than the body. These filaments give the insect its name. The female surrounds herself, when mature, with a cottony substance, amid which the young cluster for a time. The larval male forms a small cotton cocoon in which it pupates and from which the winged adult emerges. The transparent wings expand only one-tenth of an inch.

Control.—The same remedies and methods of prevention are applicable to this insect as to the preceding. Lady-bird beetles

are very efficient in holding both of these pests in check. Figures 255 and 256 illustrate the male and female of this species.

The Greedy Scale (*Aspidiotus rapax* Comst.).—The female scale is one-sixteenth of an inch long, quite convex, and of a grayish color. The insect beneath the scale is bright yellow. Yellow eggs are found under the mature female, from which yellowish larvæ soon hatch. These larvæ are extremely small—at the time of hatching, one one-hundredth of an inch in length.

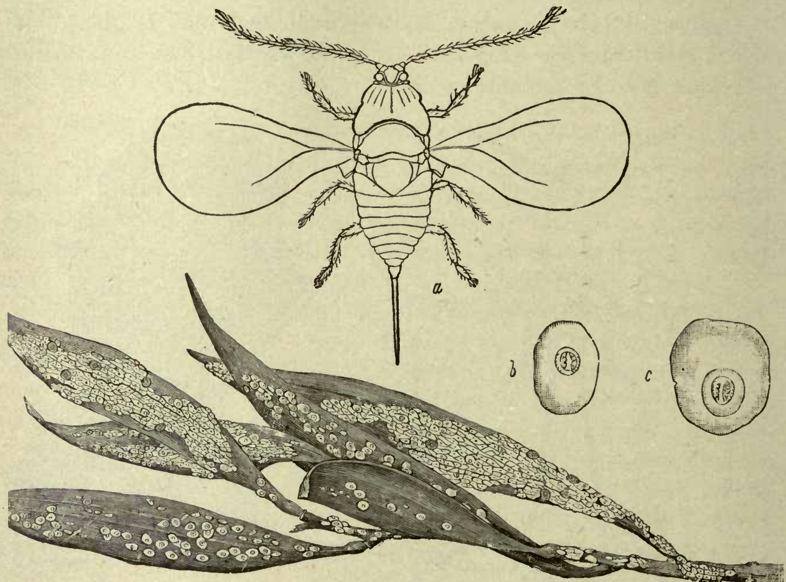


FIG. 257.—The white scale.

For a time they are able to crawl about, but soon settle and, after secreting a scale from their bodies, lose the power of locomotion. The females remain stationary; winged males emerge from the male scales, fertilizing the females, which deposit several hundred eggs or give birth to living young. This scale is nearly cosmopolitan in range, but is seldom very troublesome.

The Common White Scale (*Aspidiotus nerii* Bouche).—This is a flat, whitish or grayish scale about one-tenth of an inch in diameter when mature. The male scale is smaller than the female and slightly elongated. It is white, tinged with yellow, one

twenty-fifth of an inch in diameter. The winged males are minute, and are yellow, mottled with reddish brown (Fig. 257). In a general way the life history of this scale is identical with that of the other scales. The methods of control are practically the same as for the others.

Palms, ferns, and other house plants affected with a few scales can be freed of these pests by the use of an old tooth-brush dipped in strong soapsuds to which tobacco extract has been added. The plants are afterward washed with pure water.

The White Fly.—Scattering of powdered sulfur on hot water pipes or steam pipes of greenhouses, it is claimed, is more or less efficacious in exterminating the white fly and red spider. (See pages 46 and 67.)

Plant Lice or Aphids.—These insects are generally controlled by fumigation with nicofume paper. Fumigation with cyanide of potassium or other approved agent is one of the best remedies for greenhouse pests, but it must be done understandingly and with proper precautions. (See page 64.)

Sow Bugs or Wood Lice.—These small, grayish forms (*Coniscus*) are not true insects. They are among the most troublesome of greenhouse pests. However, they may be easily controlled by a mixture of sugar and Paris green sprinkled along the edge of the boards forming the sides of the beds. This will attract and kill many. In fact, this seems to be the approved remedy. It is claimed that slices of young, juicy potatoes, sprinkled with Paris green and left in places frequented by the sow bugs, are also efficacious. (See page 44.)

SOME INSECTS OF THE FLOWER GARDEN

Lice on Peas, Roses, Golden Glow and other plants.—A small cake of ivory soap, or a similar quantity of good laundry soap, dissolved in five gallons of hot water and the solution sprayed forcibly against these insects, is effective in exterminating them. The spray will not injure delicate plants. Each louse should be hit with the liquid, and a repetition of the treatment may be necessary, for if even a few escape destruction the plant will very shortly become infested again. Tobacco extract, or nicotine sulfate, added to the solution, at the rate of two tablespoonfuls to the gallon, will increase its efficiency. A forcible spraying, frequently repeated with water from the garden hose, will wash lice off of sweet peas and other delicate plants.

Ants in the Lawn.—Colonies of black ants (Fig. 258), which build large nests sometimes a foot high, may be exterminated by the use of bisulfid of carbon. Make eight or ten holes at intervals over the nest, using a cane or any pointed stick of similar size, and push it in for eight or ten inches. Pour a tablespoonful of bisulfid of carbon into each hole, stop the opening with earth, and throw two or three burlap sacks or a piece of canvas over the nest to help confine the gas. Preferably the sacks should be wet. Leave them for twenty-four hours. Repeat if necessary.

The small red ants which make tiny hills are sometimes troublesome when abundant. Repeated hoeing and cultivation will discourage their work, as will also copious watering. If many small hills in a cluster impair the lawn, treat with bisulfid of carbon as recommended above for black ants.

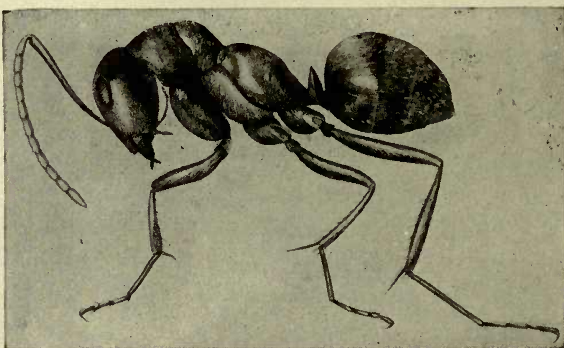


Fig. 258.—The common black ant, much enlarged.

The Stalk Borers.—Golden glow, dahlias, hollyhocks, gaillardia, delphinium, asters, daisies, peonies, lilies, and sunflowers in the flower garden, as well as tomatoes and other plants in the vegetable garden, may suffer as a result of the attack of several species of borers belonging to the genus *Papaipema*. A drooping or wilting tip or branch (Fig. 259) is generally an indication that just below the affected portion a hole in the stalk may be found from which protrude castings left by the caterpillar. This caterpillar excrement, wherever found, is proof positive of the presence of the pest, and a little searching will result in the burrow being discovered.

Life History.—These moths (Fig. 260) emerge in late summer,

deposit their eggs at that time on the stalks of weeds, such as giant bur elder (evidently the preferred food plant), ragweed, burdock, thistle, and others, close to the ground. The winter is passed in this condition, the eggs hatch in the spring and the larvæ then leave their first food plant for garden plants in the vicinity. If a neglected lot or weedy field is close to a flower garden, the latter is quite sure to be affected, even if the garden itself is free from such weeds.

Control.—Choice beds of lilies or other plants (or, if practicable, an entire flower garden) may be protected from attack by a six- or eight-inch board placed around the outside, the lower edge an inch or more below the surface of the ground; this board to have on the outside a band of some sticky material like tree tanglefoot, which will remain sticky or can be kept so by repeated applications

Fig. 259.—Tip of golden glow plant, wilting as result of attack of a stalk borer.

during late spring and summer. This tanglefoot should be applied far enough above the ground to prevent its being spattered with earth during a rain. (See page 248 for other remedies.)

Green Cabbage Worms.—These cabbage pests are sometimes found in destructive numbers on nasturtiums. If the white butterflies which produce them are seen in flower gardens, one may expect nasturtium leaves to be eaten later. Hand-picking of the worms, which are found on the under side of the leaves, is perhaps the only practical remedy. White hellebore dusted generously over the affected leaves will lessen their numbers.

White Grubs in Lawn.—Dead patches may appear in lawns

as the result of the work of these larvæ, which eat the roots. Sod thus affected can be easily rolled up from the earth, as one would roll a piece of carpet, disclosing the grubs below. At least two years are required for these insects to mature, and since their presence for the first year, on account of their small size, is not evident, a lawn rarely suffers for two years in succession. Robins are very fond of white grubs, and may frequently be seen pulling them from the sod. Copious watering where water is convenient serves to keep the grass growing in spite of their ravages. Frequent hoeing and cultivation about plants occasionally discloses grubs, which may be guilty of eating the roots and thus killing a plant. Lantern traps are sometimes employed (see page 49) to catch the adult beetles (June bugs) before their eggs are laid.

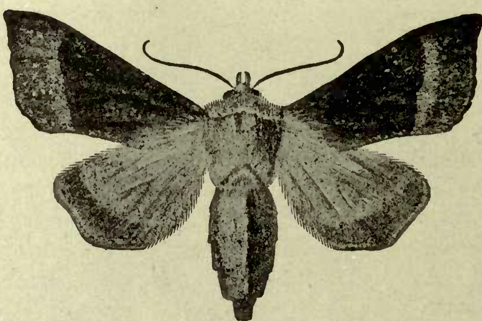


FIG. 260.—Moth of one of the stalk borers, *Papaipema nitela*.

Moles are also useful in this connection, as they destroy large numbers of grubs.

Rose Chafers, "Woolly Bear" Caterpillars, and other Leaf-eating Insects.—All leaf-eating insects in the flower garden may be controlled with arsenate of lead, one-half pound to five gallons of water, but this insecticide will leave a white stain on the foliage. White hellebore dusted on the leaves when they are moist has not this objectionable feature.

Lice on Roots of Asters.—Aster blight occurs on account of a disease and because of the presence of root lice. Frequent watering with weak tobacco extracts, poured close to the plant, holds lice in check. Use two tablespoonfuls of nicotine sulfate in one gallon of water. Asters call for a fairly rich soil, and it has been the writer's personal observation that where they get

shade for half of the day they flourish better than when in full sun all of the time. If thrifty they may largely overcome the attacks of root lice.

Leaf Bugs.—These destructive insects (see page 148) kill buds both of asters and of dahlias. The best remedy known to the writer is frequent application of fine tobacco dust to the buds.

Cut Worms.—Good tillage of the soil and the killing of worms when found are recommended. One should also encourage the presence of birds. Young plants, when set out, may be protected by "collars" of paper or cardboard or metal encircling the plant and inserted about three inches into the ground, care being taken not to enclose cut worms within the collar. Tablespoonfuls of poisoned bran mash (see page 195) may be placed at intervals among the plants in the flower beds.

Slugs or Naked Snails in the Flower Garden.—While these are not insects, they nevertheless deserve attention here, since they sometimes eat the delicate leaves of flowering plants. Air-slaked lime dusted on the ground about plants is a good deterrent so long as it remains dry, and is very effective if applied directly upon the animals. Pieces of shingles or cabbage leaves or boards may be made use of as traps; the slugs will conceal themselves under them during the day.

Slug Caterpillars on Roses.—These are true insects, the larvæ of a saw-fly. Dust white hellebore on leaves, or add one ounce to a gallon of water and use as spray. Dusting with air-slaked lime is effective.

QUESTIONS

1. Enumerate the insects which are most commonly found on house plants and in the greenhouse.
2. Which of these are you familiar with, in your experience?
3. Give remedies for mealy bugs, scales, and plant lice occurring on house plants.
4. Should Paris green or arsenate of lead be used against any of the above? State reasons for your answer.
5. Give remedial measures for each of the following insects of the flower garden: plant lice, stalk borers, ants, white grubs.
6. How are slugs or naked snails combated effectively?

CHAPTER XV

INSECTS AFFECTING SHADE TREES

THE attractiveness of many of our towns and cities is due in large measure to the beauty of the shade trees in streets and parks. Occasionally insect depredations are such as to almost or quite denude these trees of their leaves or to cause their death. The object of this chapter is to discuss these pests and to offer either remedial or protective measures.

The Box-elder Bug.—This is a bright-colored, black and red bug (*Leptocorisa trivittata* Say) familiar to many of our farmers. The red forms three broad lines over the black thorax, and the hard parts of the wings are edged with red. The adult bug, having passed the winter in this stage, lays eggs in the spring wherever it happens to be.

Many of the young, hatched from the eggs, never reach their food. The insects are frequently found on the leaves and tender twigs of the box elder, which habit gives them their name. It may be seen, however, upon other trees and in various situations (Fig. 261).

Control.—This being a sucking insect, it is difficult to control it by spraying. Villages and cities should own strong spraying outfits to protect their shade trees. In the fall, during cold days, the bugs collect in large numbers and become, for the time being, inactive. Such gatherings should be sought and the individuals killed with boiling water. However, the box elder bug is hardly ever sufficiently injurious to call for strenuous measures of control.

Box Elder Plant Louse (*Chaitophorus negundinis* Thos.).—This is a green louse which may be a serious pest to box elders through sucking juices from the leaves and tender shoots, thereby causing them to wither and die. Eggs are laid in the fall and hatch before the leaves unfold. The lice gather about the opening buds and attack the leaves as soon as they open. Winged forms appear during the season to help dissemination. Parthenogenetic reproduction is the rule during summer, males and females appearing in the fall. Eggs are then laid in the crevices in the bark and in the axils of the buds.

The Box Elder Gall-fly.—This is a very minute, two-winged fly (*Cecidomyia negundinis* Gill) which lays eggs on the leaves

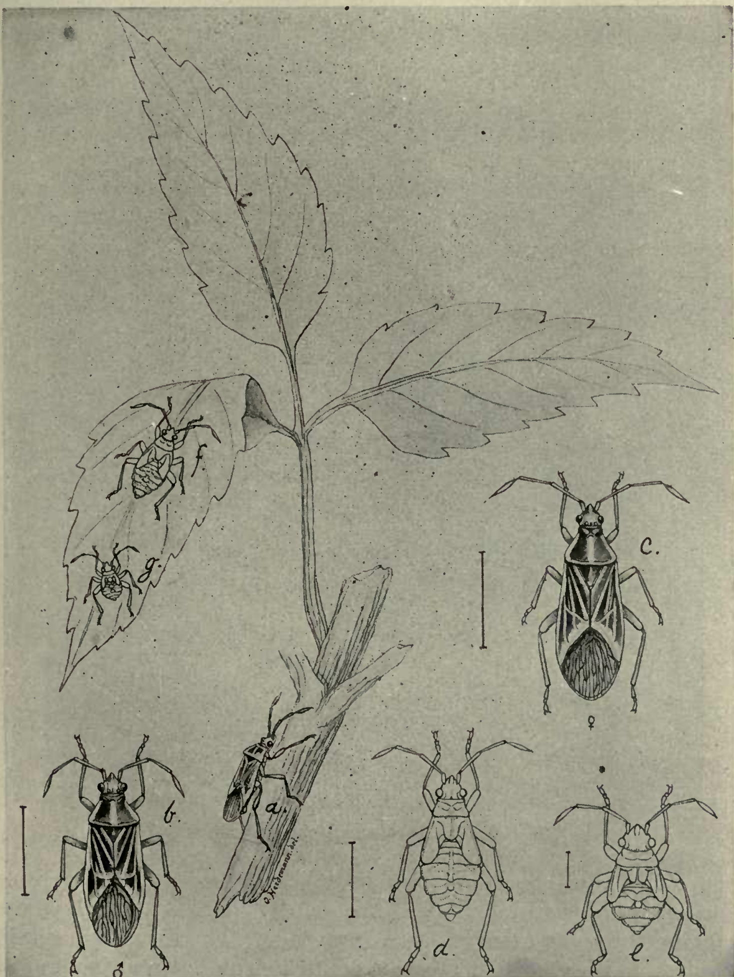


FIG. 261.—Box-elder bug; male, female, and nymphs. (Lugger.)

of the box elder. As a result the leaves form unsightly galls (Fig. 262) which interfere with the proper functioning of the foliage. Tiny maggots are found inside of the galls. Maple leaves (Fig.

263) are subject to the attacks of these small flies (Fig. 264). Imperfect galls containing maggots are formed.

The only remedy suggested is the picking off of affected leaves before the larvæ become adult; destroy the galls containing the insects.

The Bronze Birch Borer (*Agrilus anxius* Gory).—This borer is one of the most injurious and destructive of enemies to shade

FIG. 262.—Insect-made galls on box elder. (Ruggles.)

trees. The adult beetle is bronze-green or varies in color; it is about one-half of an inch long. Posteriorly there is a notch where the ends of the wing-covers come together. The larvæ are small, flattened, footless grubs, creamy white in color, three-fourths of an inch long. The mouth parts are dark, and the small head may be partly drawn into the first segment of the body.

Life History.—Hatching in June or July from eggs laid in crevices in the rougher parts of the bark, the grubs bore through the bark and at once begin to mine the sapwood (Fig. 265). The

burrows are always packed with castings of the grub. It lives in the larval stage until the latter part of the following spring, transforming to a pupa within the burrow. A month later it changes to the adult form, and escapes from the tree in late June.

Injury.—It then feeds on the leaves of trees. This insect infests all varieties of birch, and it is sometimes claimed that it attacks willows. Trees of large size are often killed by these borers within three or four years, and it is a common sight to observe large birch trees dying from the top as the result of attacks from this insect.

Control.—When this condition is observed, the only remedy practicable is to cut infested trees below the injured portion,

Fig. 263.—Imperfect galls on leaves of maple.

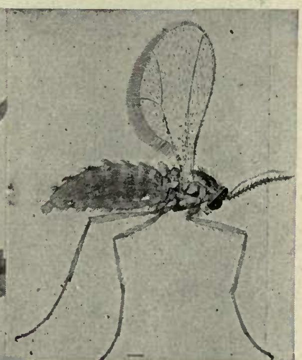


Fig. 264.—Fly raised from galls on maple.

taking pains to cut low enough to remove any portions infested by the grubs. These cut-off portions should be burned. This pruning should be done in winter or early spring.

The Birch Leaf Skeletonizer.—This is a brown moth (*Bucculatrix canadensiella* Cham.) less than one-half inch in length. The wings are crossed with delicate white bars. The green caterpillar or larva has a brownish head; it is quite slender and tapers slightly toward the anterior and posterior ends. When disturbed, it may lower itself by means of a silken thread from the leaves. The cocoon is brownish or yellowish in color and one-fourth of an inch long. It is attached to the leaf or twig.

This is a serious pest of the birch. It feeds on the soft parts of the leaf, leaving only the brownish skeleton. In late summer this injury is conspicuous.

Control.—Spray infested trees with arsenicals, preferably four or five pounds of arsenate of lead to one hundred gallons of water.

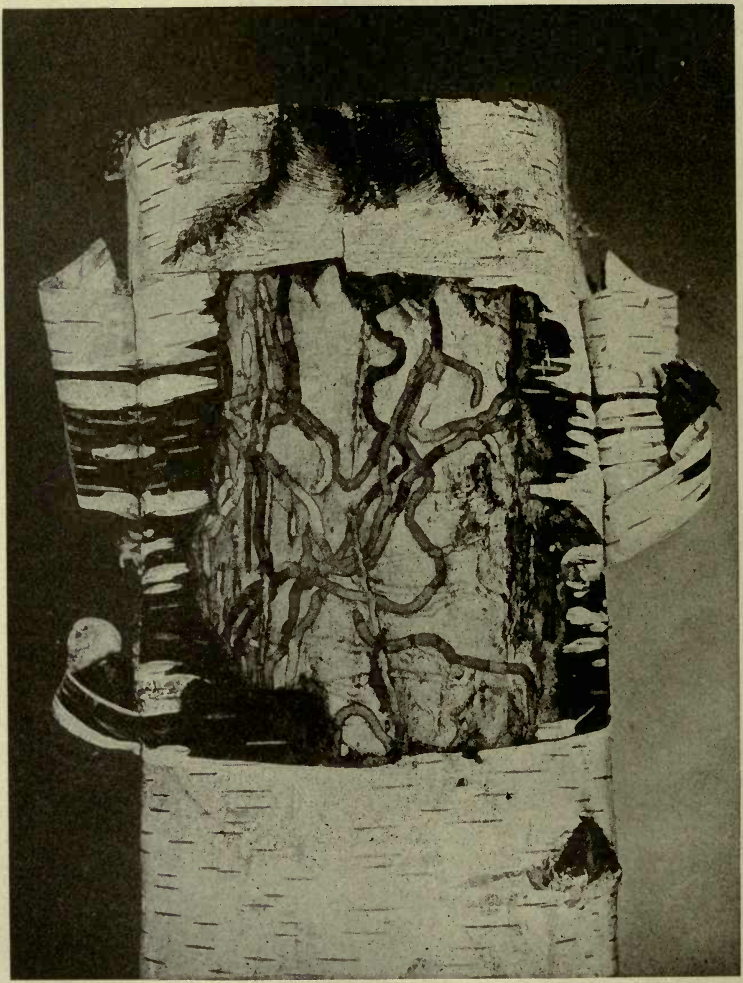


FIG. 265.—Work of bronze birch borer.

This is practicable if the trees are not too large. Even in the case of large trees, if valuable, bamboo extensions of spraying hose might be handled from raised platforms.

The Fall Web Worm.—The adult insect is a white moth (*Hyphantria cunea* Dru.) with wing expanse of about one and one-fourth inches. The wings are slightly spotted with black. The pale yellow eggs, in clusters of a few hundred, are deposited on the under side of the leaves during the summer. About ten days are required for hatching. The young larvæ are pale yellow with brown markings.

These feed upon the leaves of various trees, and spin a protective web as their feeding-ground enlarges, this nest enclosing the leaves (Fig. 266). The active larvæ become full grown late in summer. At this time the caterpillars are about one inch long and are covered with black and white hairs which project from numerous black tubercles. These caterpillars are somewhat varying as to color; some are uniformly yellow; others are almost white. They attain full growth in summer.

Fig. 266.—Nests of the fall web worm.

After spinning light cocoons in the ground or under the bark or rubbish, they pupate and emerge as adults the following spring. The moth is a night flier.

Control.—Cut away and burn branches containing colonies of caterpillars. Spray badly infested trees with arsenate of lead, using three pounds to fifty gallons of water. Burn all rubbish on the ground beneath trees which were infested the previous year. Do this before the adults emerge in the spring and after their pupation in the fall. Fortunately many enemies tend to keep this pest in check.

The Alder "Blight."—This is a woolly louse (*Pemphigus tessellata* Fitch) which receives the above name because of the fact that it secretes a honey dew which, falling on leaves beneath, creates a favorable condition for the growth of the blight fungus. The louse itself is dark in color, but is covered and hidden with a white, flocculent growth. It infests limbs and twigs of the alder,

appearing in conspicuous and unsightly masses. It multiplies parthenogenetically, like other species of the plant louse family, during the summer, giving rise to winged migrants from time to time. The sexual forms occur in the fall upon the maple, at which time eggs are laid. The eggs are placed under loose bark of the silver and soft maples. There is a hibernating form which descends to the ground and hibernates in rubbish, ascending the alders again in the spring.

Control.—Kerosene emulsion is the best spray, since kerosene readily penetrates the waterproof waxy secretion which covers

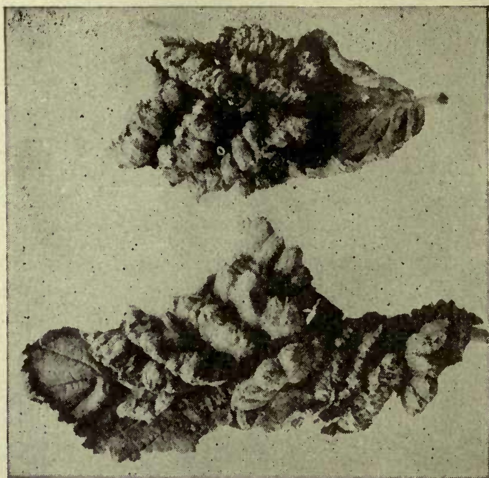


Fig. 267.—Cockscomb gall on white elm.

the insects. Straw and leaves may be placed under the trees and later gathered and burned to trap the hibernating forms. Infested limbs should be cut off and destroyed as soon as noticed.

The Cockscomb Gall.—This species of louse (*Colopha ulmicola* Fitch) causes a peculiar gall on elm leaves resembling a cock's comb. In a general way the life history of this insect resembles that of other aphids. The gall is about an inch long and one-quarter of an inch high. The sides are wrinkled perpendicularly and the summit irregularly gashed and toothed (Fig. 267). On the under side of the leaf the gall has a slit-like opening. Upon opening these galls, they are found to be crowded with lice and white flaky material.

The galls become dark with age. To a certain extent, these galls interfere with the proper functioning of the leaves and are unsightly. Nevertheless, the insects are not regarded as serious pests.

Control.—The only practical remedy is to cut off galls when

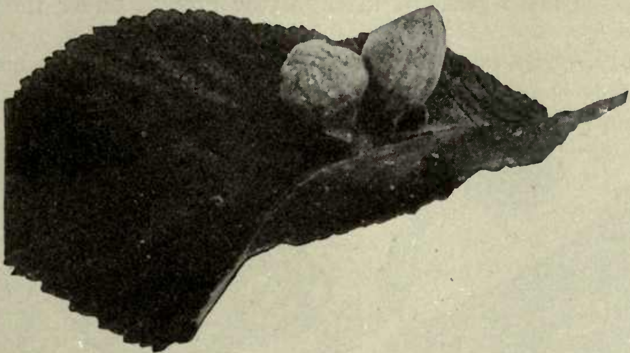


Fig. 268.—Gall on red elm made by a plant louse, *Pemphigus ulmi fusus.*

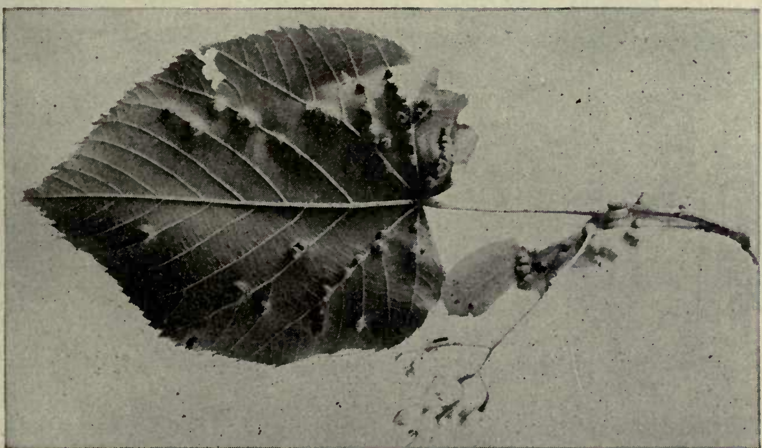


Fig. 269.—Basswood leaf and fruit showing galls made by a two-winged fly.

noticed on young trees and to burn them while still containing the lice.

Another gall of the elm is that made by a plant-louse (*Pemphigus ulmi fusus* Walsh) (Fig. 268). Basswoods also suffer from the attacks of gall-making insects (Fig. 269).

The Elm-leaf Beetle.—This beetle (*Galerucella luteola* Mull) is an importation from Europe. It is greenish yellow, with black stripes on the back. The eggs are yellow, bottle-shaped, and are laid on the under side of the elm leaves. The larvæ are yellow, with black spots from which project small tufts of hair. Pupation takes place amid grass or litter on the ground under the trees affected.

Injury.—The insect prefers European elms, and has been so

Fig. 270.—The elm-leaf beetle, different stages, details of structure, and injured elm leaves. Hair lines indicate actual size. (U. S. Bu. Ent.)

injurious to elms in the eastern part of the United States that municipal authorities have been obliged to hire gangs of men to save the trees by spraying (Fig. 270).

Control.—The use of an arsenate of lead spray just as the grubs appear is recommended.

The Elm Borer.—This handsome beetle (*Saperda tridentata* Oliv.) is grayish above. On each side of the thorax and on each wing-cover is a sub-marginal reddish or yellowish stripe. Fre-

quently there are two black spots on each side of the thorax and three on each side of the wing-cover. The larva is a footless grub a little over an inch long; whitish or yellowish (Fig. 271).

Its life history extends probably over two or three years. Eggs are deposited in early summer. By burrowing under the bark the grub may girdle and kill the tree. A portion of an elm killed by this borer is shown in figure 272.

Control.—To protect trees not infested, apply before May 1, and later repeat the application, a compound of thick whitewash containing crude carbolic acid. Use one quart of the acid to a pailful of whitewash. To fifty gallons of this wash add six pounds of arsenate of lead. This protective coat may be rendered inconspicuous by the addition of lamp-black, and should be applied

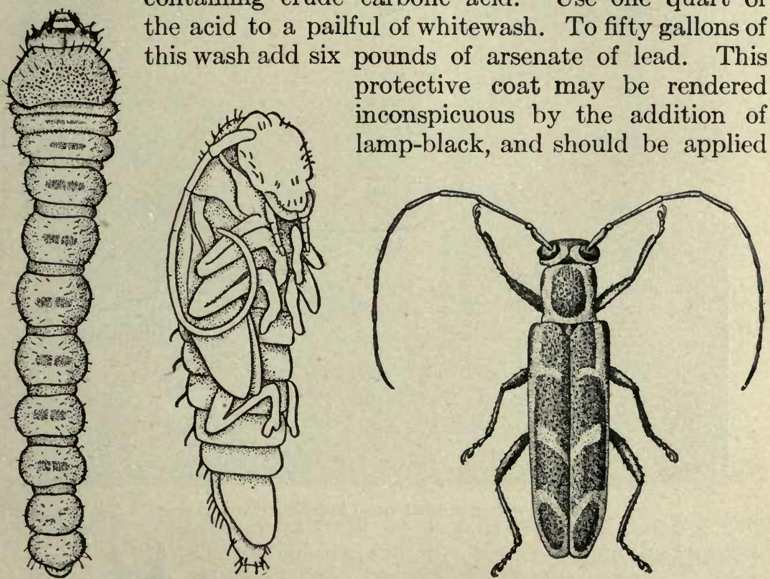


FIG. 271.—The elm borer, larva, pupa, and imago, enlarged.

with a brush to the trunk of the tree and to the lower portions of the branches.

The White-marked Tussock Moth.—The caterpillar of this insect (*Heterocampa leucostigma* S. and A.) is strikingly beautiful. When full grown it is one and one-half inches long, hairy, with a pencil or brush of hairs like a horn on either side of its head and a smaller, median tuft near the tip of the abdomen; it has four striking white tussocks of hairs on the middle of the first four abdominal segments. The head is red; along each side of the black stripe down the middle of the back is a distinct yellow stripe (Fig. 273).

The wingless female moth is somewhat spider-like in appearance and of a grayish color, while the male is dull gray, with several

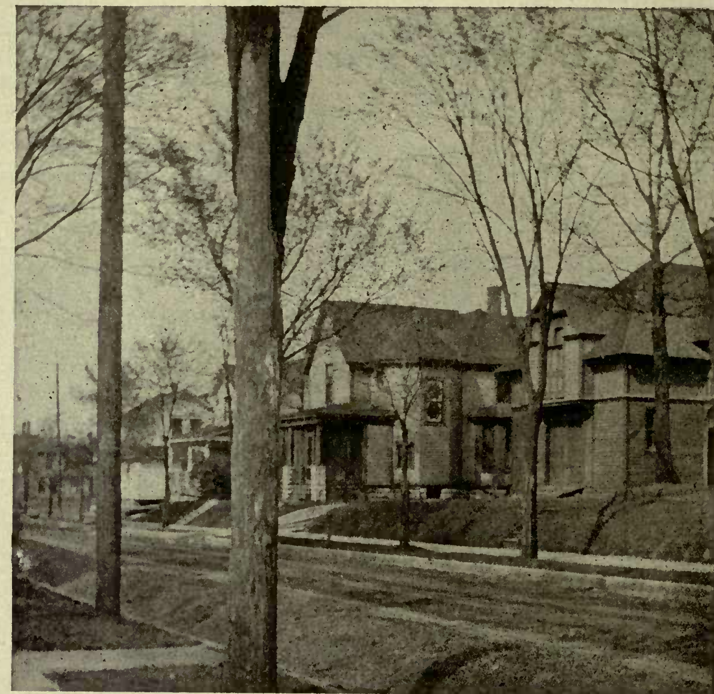


FIG. 272.—Tree in foreground killed by elm tree borer.

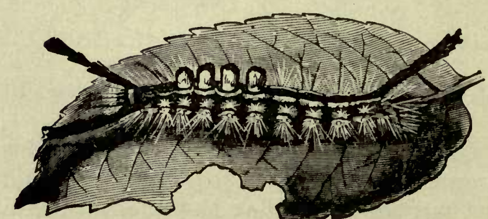


FIG. 273.—White-marked tussock caterpillar. (After Riley.)

FIG. 274.—White-marked tussock moth, male. (U. S. Bu. Ent.)

dark gray lines crossing the fore-wings. It is about one inch in length (Fig. 274).

Life History.—When full grown the caterpillar spins a yellow-

ish cocoon and attaches it to a tree or a fence or the side of a building or a vine. A wingless female (Fig. 275) emerges therefrom in the spring and lays eggs in masses upon the silk of the cocoon. These egg-masses are covered with a white, frothy substance so that the individual eggs are obscured. They commence to hatch in a few weeks and continue until early summer, when some of the first hatched caterpillars begin to pupate. The moths from these pupæ give rise, in some latitudes, to a second generation, which passes the winter as pupæ.

Injury.—This caterpillar is sometimes extremely destructive to the foliage of fruit and shade trees, and has been known to eat holes in the fruit of the apple. The destructive work of this insect is well shown in figure 276.

FIG. 275.—Wingless female of the white-marked tussock moth. (Houser, Ohio Bull., 194.)

Control.—Egg-masses should be destroyed when pruning the trees. If infestation is serious in any locality, trees may be banded with tanglefoot or any sticky substance to prevent the ascent of the larvæ. Arsenical spraying when the larvæ are hatching catches the first brood.

Fortunately this pest is subject to the attacks of numerous parasites which have been at times a means of preventing serious injury.

The Vagabond Gall Louse (*Pemphigus vagabundus* Walsh).—This insect forms unsightly galls on the cottonwoods, but deserts these trees before the latter part of summer. The galls may be seen on the tips of twigs and become perfectly black when old. They do not seriously affect a tree's functions unless they occur in great numbers.

Clip off the galls, if possible, while green and burn them. No other remedial measures are suggested.

The Cottonwood Scale.—These are small, papery, snow-white scales (*Chionaspis salicis* Linn.). The female scales are larger and more or less pear-shaped. They are found on the branches

FIG. 276.—Horse chestnut defoliated by first brood of larvæ of white-marked tussock moth. (After Houser, Ohio Bull., 194.)

of the cottonwood and some other trees. Eggs are laid under the female scale in the autumn. They hatch in early summer into small flattened, oval lice. These young lice are very active. spreading over all accessible branches. Like all lice, they weaken the tree by sucking the sap therefrom.

Control.—Kerosene emulsion and whale-oil soap when the young are hatching form fairly effective sprays. The spray should be applied before the insects are protected by a scale.

The Willow Saw-fly.—This large saw-fly (*Cimbex americana* Leach) has a shining black head; the body is steel blue, with three or four elongated, oval, yellowish spots on each side. The wings are smoky brown in color, and the legs bluish black with yellowish feet. The well-known larvæ, when full grown, are three-fourths of an inch long, pale yellow or greenish in color with a black stripe along the middle of the back. The head is large, rounded, and as wide as the body. When the saw-fly rests or is disturbed, it lies on its side and rolls its body (Fig. 277), a habit which distinguishes it from real caterpillars.

Life History.—The female fly deposits her eggs below the sur-

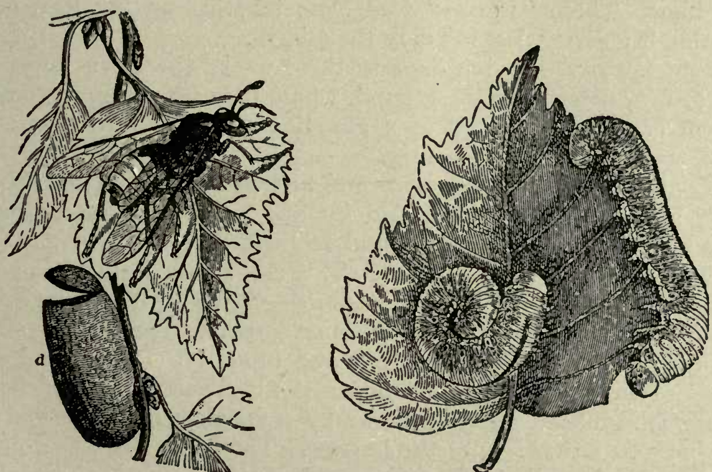


FIG. 277.—The willow saw-fly, caterpillar, adult, and open cocoon, *d*. Natural size.

face of the leaf. The points where eggs are placed can be plainly seen on the under surface, being bluer than the rest of the leaf, and they become reddish with age. There may be from one to nine eggs on a leaf. The larvæ, after hatching, remain within this blister-like structure for a time. In July and August they become full grown; they then leave the foliage and are found in tough, silken cocoons under the tree or shrub in the ground just below the surface. They remain in this condition over winter and emerge in spring.

Injury and Control.—Although this saw-fly destroys the foliage of willows, poplars, and elms, and is recorded as attacking maples, lindens, and alders, it is not considered injurious and is

easily controlled by arsenical sprays. Of these, the safest is arsenate of lead.

The Yellow-spotted Willow Slug.—This saw-fly larva is black or greenish black in color. It is a little more than one-half inch long, with heart-shaped, yellowish spots on each side of the body. The adult insect (*Nematus ventralis* Say) is brownish black marked with yellowish white. It is about one-third of an inch long.

Injury.—The first indication of the presence of these slugs is the blister-like swellings on the upper surface of the leaves. They have a wavy or crumpled appearance, due to the presence of eggs in the under surface. From four to eight days are required for hatching. These "worms" feed close together on the leaf, devouring it entirely, leaving only the midrib.

Life History.—In ten days to three weeks the larvæ become full grown, descend to the ground, where they form shining, dark brown cocoons composed of a glue-like secretion. In about a week the adult saw-fly emerges.

Control.—Sometimes poplars and willows are defoliated by this pest, but it is easily controlled by any good arsenical poison. It is also attacked by Chalcid and Ichneumon parasites.

The Mottled Willow Borer.—This is a snout beetle (*Cryptorhynchus lapathi* Linn.) ,from one-third to three-eighths of an inch long, with a dull-black body. It is an imported species.

Injury.—The white larva burrows around the buds and at bases of small stems, which latter it may partly girdle. The injury is indicated on the willows by a purplish discoloration of the bark on either side of the burrow. The larva also bores into the center of small stems, making galleries one-eighth of an inch in diameter. It is reported as attacking willows, cottonwoods, birches, and alders, and is perhaps as much a pest of the poplar as of the willow (Fig. 278).

Control.—All seriously infested wood should be cut and burned in the early spring.

Cottonwood Leaf Beetle (*Melasoma scripta* Fab.).—This beetle (Fig. 279) is found both on the willow and poplar, appearing in the early spring, contemporaneously with the leaves. It shows a preference for tender shoots. Egg-laying begins immediately, the eggs being placed on the under surfaces of leaves.

The young grubs, upon hatching, skeletonize the under sides of the leaves and, as they get older, eat holes in the stem. When alarmed, they exude a milky substance along their sides for their

protection; they appear to withdraw it at will. The pupal period is passed in the partly cast larval skin. Fifteen days are required for development of the larva and pupa. There are several generations each season. The greatest damage is caused by the beetles on the young leaves and small tender shoots.

Control.—Spraying with arsenicals has proved effective. The worst injury occurs in nurseries, and these remedial measures are for use there.

The Locust Borer (*Cyllene robiniæ* Forst.).—This beautiful beetle, black, with gold markings, nearly three-fourths of an inch long, is a common pest of locust trees in some sections. Branches, and sometimes an entire tree, succumb to its attack (Fig. 280). In the fall it occurs on flowers of the goldenrod.

FIG. 278.—Mottled willow borer.

FIG. 279.—Cottonwood leaf beetle, enlarged and natural size. (Ruggles.)

The whitish eggs are laid in crevices in the bark in September.

Control.—Some repellent wash, containing arsenate of lead and applied very early in the fall, is recommended. Fish-oil soap, with the addition of crude carbolic acid and arsenate of lead, at the rate of six pounds of the latter for every fifty gallons of the wash, is suggested. Badly infested trees should be cut down and burned during the winter or early spring.

The Two-lined Chestnut Borer.—In some oak-growing regions, Minnesota for example, this is a very destructive insect (*Agrilus bilineatus* Oliv.). It kills more oaks than any other species of insect so far discovered. The grubs make burrows beneath the bark in the growing layer. Their tunnels cut off the food supply

from the root to leaf, and a tree thus girdled dies. The burrows may occur anywhere from the base of the tree to the smaller limbs.

The beetles (Fig. 281) are found flying in spring and early

FIG. 280.—Young locust tree injured by locust borer and later broken by the wind. (After Houser, Ohio Bull., 194.)

summer, at which time eggs are laid on the bark. One year is necessary for the life cycle.

Control.—Chapman advises the cutting and burning of infested trees before the emergence of the adults in the spring. This

is a hard thing for a tree owner to do, but quite necessary in order to protect other trees. He suggests the need of some other remedial measure, and reports successful results in spraying the trunks and large limbs of several trees with a mixture of iron sulfate and lime-sulfur, and others with Bordeaux mixture. This was done as a preventive measure during the egg-laying season.

Turpentine Bark Beetle.—This is a bark-boring beetle (*Dendroctonus terebrans* Oliv.) nearly one-fourth of an inch long, brownish in color. It works in the bark of dying trees or stumps of pine trees. Healthy trees are attacked only when the insect is pressed for food. It prefers bark at the bases of the trees or on exposed roots rather than that which is higher on the tree. It is often attracted to recently painted buildings or freshly sawed pine lumber by the smell of turpentine. Hibernating as an adult, it begins to fly in April and May, eggs being laid in the late spring.

There are a few natural enemies of this pest, and large numbers have been found in the stomachs of brook trout. (See Fig. 2.)

White Pine Weevil.—This is a fairly large, reddish-brown beetle (*Pissodes strobi* Peck), one-fourth of an inch long, with a whitish spot on each side of the back near the posterior end. The sides and legs are somewhat mottled with white, and the snout is long and stout. It occurs in early spring, at which time most of the eggs are deposited in the leading shoots of pine, one egg being placed at a time at regular intervals throughout the length of the leader or shaft of the tree. The grub, after hatching, eats inward and obliquely downward into the pith, in which it burrows a short distance. Pupation is passed in the burrow, adults emerging in the spring.

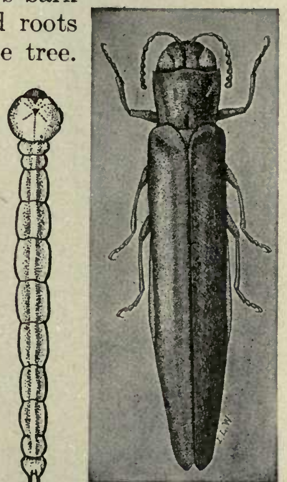


FIG. 281.—Two-lined chestnut borer larva and beetle, about twice enlarged. (Ruggles.)

Injury.—The leader being killed, an irregular, deformed tree is the result, termed by lumbermen as "buckwheat pine." Such trees have but little commercial value for lumber.

Control.—Many natural enemies attack this pest. Birds are very effective as checks to its increase.

Pine Bark Aphid.—The wingless female of this species (*Chermes pinicorticis* Fitch) is enclosed in a woolly mass which is seen sticking to the bark (Fig. 282). Eggs are found in downy bundles near the bases of needles, and vary in number from five to sixty or more in each mass.

The life history is doubtless approximately the same as other aphids. The winter appears to be passed by fertilized females which lay eggs in early spring. It is possible there is an alternate food plant.

FIG. 282.—The pine bark aphid, white pine louse, "pine blight."

Injury. — Patches of this flocculent, downy matter may be observed upon the smooth bark of white pine. The presence of this insect in large numbers naturally reduces the vitality of the tree, and leaves it in a sickly condition which ultimately results in death (Fig. 283).

Control.—Where a forcible spray of cold water can be used, this affords perhaps the simplest and most effective remedy. The flocculent masses may be sprayed with kerosene emulsion at the rate of one part of the stock emulsion (see page 45) to nine parts of water; or use whale-oil soap at the rate of one pound to nine gallons of water.

Pine Leaf Scale.—This is an elongated, whitish scale (*Chermes pinifoliæ* Fitch) seen on the needles of the various pines. The winter is passed in the egg stage under the scale, the young hatching in the spring. Winged adults fly to spruce, the alternate host, and there the female lays her eggs. The scale from these eggs forms a characteristic gall on spruce (Figs. 283 and 284), from which later adults fly back to the pine, there secreting the permanent scale.

Like other sucking insects, the attacks of this pest in any numbers reduce the vitality of the trees. It has many natural enemies.

The Goat Moth.—The larva of this moth (*Prionoxystes robiniæ* Peck) spends, it is believed, three years, boring in the trunk and large limbs of oak, elm, locust, poplar, and other trees, increasing the size of the burrow as it grows and lining it with silk.

The female moth has an expanse of wings of nearly two and one-half inches, the wings being gray, marked with irregular black lines. The expanse of the wings in the male is considerably less, the fore-wings being darker than in the female and the hind-wings being yellowish.

Fig. 283.—Typical injury by the pine chermes. (O'Kane, N. H. Circular.)

Control.—It is difficult to provide a remedy for this insect, but repellents and poison washes may prevent egg-laying and kill the young when first hatched.

Orange-striped Oak Worm (*Anisota senatoria* Hub.).—This is a dull-black caterpillar with four orange stripes along each side. There is also a broad, yellow stripe along the middle of the under side. Two slightly curved hairs are present on the second segment, and three rows of short spines occur on each side of the body. It is nearly two inches in length when full grown.

The adult moth is brownish, its wings tinged with purple, and each marked with a conspicuous whitish round spot on a

dark, oblique line, running across from a little before the apex parallel with the outer margin.

Injury.—The larva feeds on the foliage of oaks and other trees. It is occasionally found upon raspberry and blackberry.

Control.—Arsenical sprays should be effective where practicable.

The Rustic Borer.—Broad, irregular, shallow galleries in the inner bark and outer sapwood of oak, hickory, and some other

Fig. 284.—Gall on spruce caused by the pine chermes (*C. pinifoliæ*). Spruce is the alternate host of this insect. (O'Kane, N. H. Circular.)

trees are frequently caused by this borer (*Xylotrechus colonus* Fab.). It may attack a tree in perfect health and entirely girdle the same in a few years. The adult beetle is blackish, variegated with yellowish or slatish-white markings. The length is about one-half inch.

Jumping Seed Galls.—One sometimes finds below oak trees large numbers of small, round galls previously attached to the under side of the leaves. These galls contain larvæ which have

the power of causing the galls to jump an inch or more, as a result of the activity of the insect (*Neuroterus saltatorius* Edw.) within. The galls are somewhat depressed and found embedded in the leaf in such a way as to cause a slight convexity on the upper surface. They are yellowish when they are detaching, and about one-half inch in diameter.

Oak Pruner (*Elaphidion villosum* Fab.).—This beetle is rather slender and grayish brown in color; its mouth-parts are rather weak. The larva or grub is obliged to cut its way out of the burrow before pupation. The female deposits her eggs in midsummer

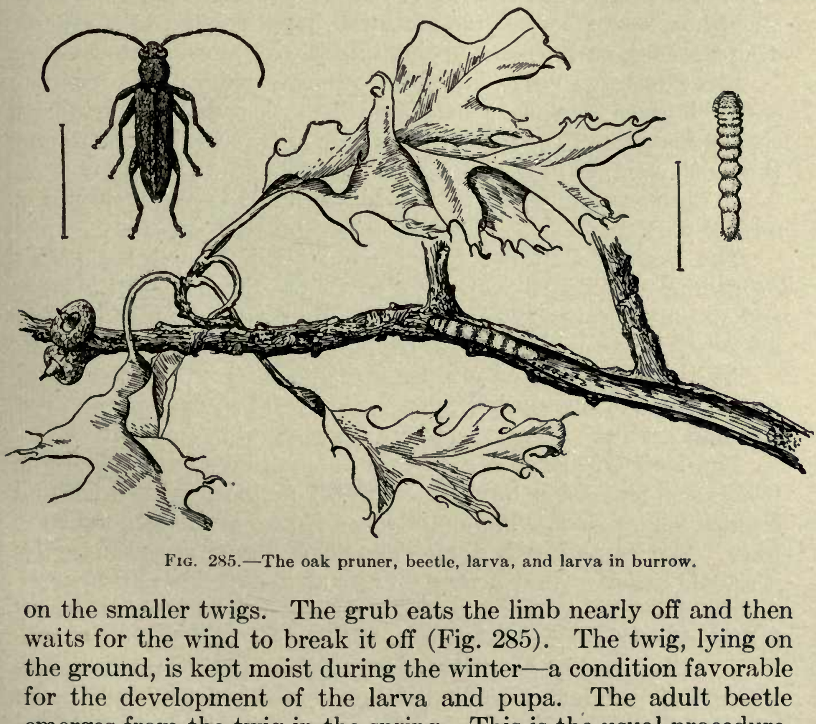


FIG. 285.—The oak pruner, beetle, larva, and larva in burrow.

on the smaller twigs. The grub eats the limb nearly off and then waits for the wind to break it off (Fig. 285). The twig, lying on the ground, is kept moist during the winter—a condition favorable for the development of the larva and pupa. The adult beetle emerges from the twig in the spring. This is the usual procedure, but the life cycle may be completed on the tree.

Injury.—This natural pruning of the oak is not particularly injurious. The insect attacks maple as well as oak, and has been recorded on apple, plum, pear, peach, grape, hickory, locust, sumac, and other trees and shrubs.

Control.—Since the fallen branches and twigs usually contain larvæ, they may be collected and burned.

The Luna Moth.—This beautiful moth (*Actias luna* Linn.) with a wing expanse of four and one-half inches, is one of our most striking insects, vying in beauty with moths from the tropics. The hind-wings are extended into broad tails instead of being rounded. The color of the wings varies, but is usually a delicate bluish green on yellowish. Upon each wing is an "eye-spot," a clear center encircled by red and black, while the anterior margin of the fore-wings is purple or purplish brown. The caterpillar also is striking, being of a clear, pale blue-green color, with little stripes on each side. There are small, pearl-colored tubercles on each segment, each tubercle being tinged with purple or rose color.

Life History.—When full grown the caterpillar draws together a few leaves, fastens them with silken threads, and spins its cocoon inside. In the autumn this cocoon falls to the ground and the moth emerges in the spring.

It attacks walnut, as well as hickory. It is not, however, a serious pest.

The Walnut Caterpillar (*Datana angusii* G. and R.).—This caterpillar may be extremely destructive to the foliage of hickory and walnut. It has the habit of descending the trunk to within a few feet of the ground, gathering in masses when about to moult.

At such times it is easy to capture and destroy, but the injury to the tree has already been done. Arsenical sprays are practical on small trees or in nurseries where pests are to be fought.

The Twig Girdler.—A little over one-half inch long, this beetle (*Oncideres cingulatus* Say) is brownish gray in color, with dull reddish yellow dots. The antennæ or feelers are longer than the body. The female lays her eggs in a twig or branch and then girdles it a little below so that a wind will break it off. This insures the falling of the twig, thus furnishing the exact conditions necessary for the development of the insect.

It will probably never become a serious pest, as a moderate amount of pruning of small twigs on hickory might well be an advantage. The fallen twigs, however, may be gathered and burned with the contained grub.

The Beautiful Hickory Borer.—This striking beetle (*Goes pulchra* Hold.) is about one inch long. It is reddish brown, with dark brown markings on the wing-covers, which form a band across the wings. This band is produced by a belt of fine hairs.

Injury is sometimes caused in young hickories by the fact that the presence of the larva or grub may cause a gall-like swelling of the trunk and a heavy wind may break the tree off at this point.

The Painted Hickory Borer.—This is a strikingly beautiful beetle (*Cyllene picta* Drury), velvety black, with numerous pale yellow bands on the wing-covers and across the thorax. The larvæ or grubs boring in hickory and elm are not often destructive.

To save valuable shade trees, trunks may be anointed late in August with a mixture of soft soap and crude carbolic acid. This should be repeated in September. Whitewash may also be used as a repellent.

The Mourning-Cloak.—The caterpillars of this butterfly (*Euvanessa antiopa* Linn.) are black, spiny, and marked with red

FIG. 286.—The mourning-cloak butterfly.

spots. They feed upon elms, willows, and poplars. The butterflies are dark bluish brown, more or less iridescent; the margins of the wings are yellowish. Just inside of the yellowish margin is a row of blue dots.

Life History.—The eggs are laid in clusters upon twigs of the food plant early in the spring. The butterflies themselves (Fig. 286) hibernate, and appear early in the spring. The caterpillars are seen in groups until they are full grown, when they separate. Oftentimes their numbers are so large as to cause a small branch to bend with their weight.

Control.—Frequently a cluster of young caterpillars, if observed, can be crushed with the gloved hand or a twig holding them may be cut off and burned. They are easily controlled with arsenical sprays.

The Lime-tree Winter Moth.—The female moth of this species (*Erannis tiliaria* Harr.) is wingless, spider-like in appearance, with a yellowish-white body. The male has large, delicate wings of a buff color.

Life History.—Pupation occurs in the ground, the adults emerging in the fall, at which time the females climb the trees, depositing their oval, pale-yellow eggs in clusters on the branches. These eggs hatch in the spring and the caterpillars feed during the summer.

FIG. 287.—The lime-tree winter-moth; larvæ, adult male above, adult female below. (U. S. Bu. Ent.)

The caterpillars are measuring worms, similar to true canker worms, but larger and differently marked. The head is dull yellow. The body is yellow above, with many longitudinal black lines. The full-grown caterpillar is about one and one-fourth inches long. They feed on the foliage of the elm, basswood, hickory, and many other trees (Fig. 287).

Control.—Arsenical sprays are practical on small or medium-sized trees and necessary on large trees in extreme cases. Banding

with tree tanglefoot in September prevents the wingless females from climbing the trees.

The Elm Leaf Aphis.—This is the very common louse (*Schizoneura americana* Riley) found in clusters on the under side of the leaves of the elm, where it may be seen covered with a whitish powder and exuding "honey dew" which attracts ants.

Injury.—Its attack causes the leaves to curl, forming more or less of a gall. If the louse appears in large numbers, the leaves at the tips of twigs turn yellow, rendering the trees very unsightly.

Life History.—Eggs are laid in the fall in cracks and crevices of the bark. The young hatch in the spring and crawl to the terminal twigs. The life history, in a general way, corresponds to that of other plant lice.

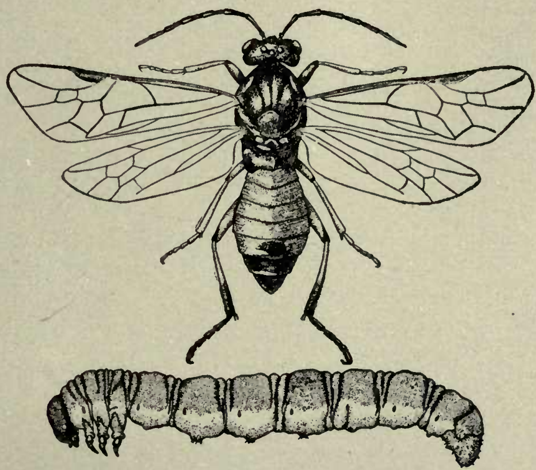


Fig. 288.—The larch saw fly; below, caterpillar, after Ruggles; above, male saw fly.

Control.—At the first appearance of lice in the spring, infested twigs should be cut off and burned, thus preventing the many summer broods.

The Larch Saw-Fly.—This saw-fly (*Lygaconenatus erichsonii* Hart) is one-half an inch long, with a blackish body and a red band across the middle of the abdomen (Fig. 288). The larva is a pale-green worm of about the same length.

Injury.—It feeds upon our tamaracks, hemlocks, and larches. This insect is one of the most injurious forms found working on shade trees. It defoliates vast areas, killing the trees and causing

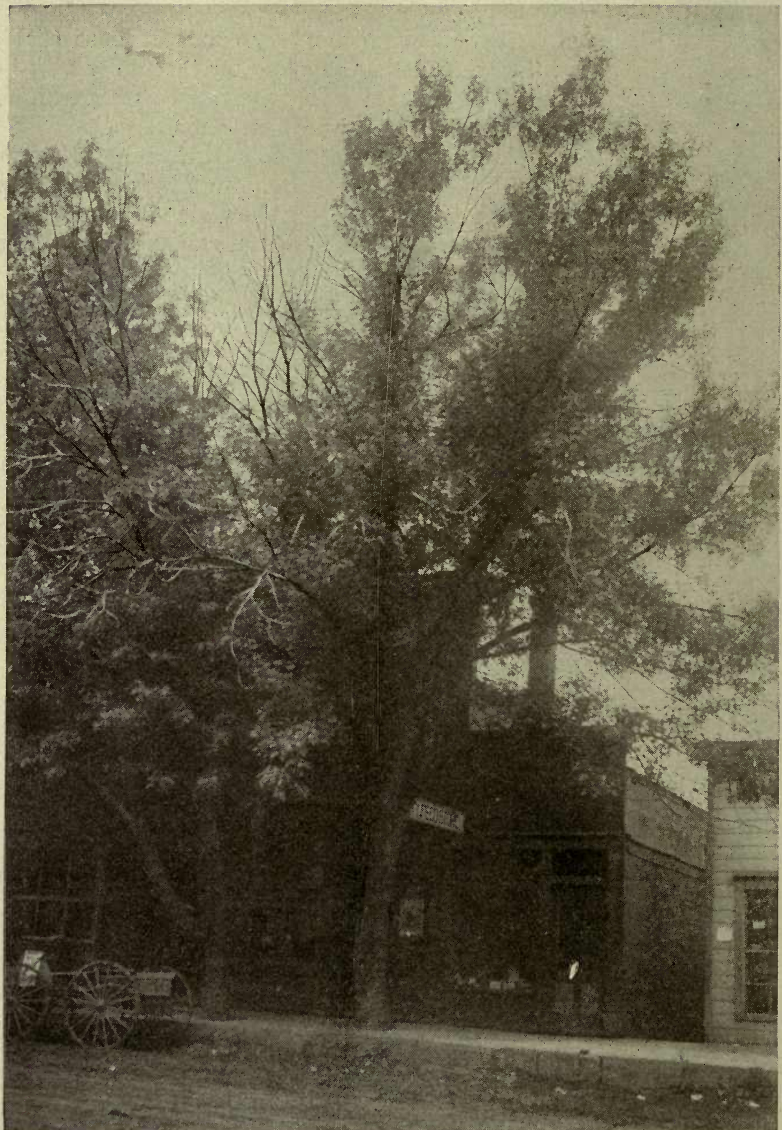


Fig. 289.—Maple trees on village street, infested with cottony maple scale.

great loss to the lumber industry. It appears to be increasing and spreading over a large territory.

Its control in the forest probably depends upon encouraging its natural enemies, animal parasites, and fungus pests. Ornamental larch trees may be sprayed with arsenate of lead.

Cottony Maple Scale (*Pulvinaria innumerabiles* Rath.).—The adult insect is nearly one-half an inch long and the scale is oval. It is conspicuous because, from underneath it, protrudes a mass of white cottony secretion in which the eggs are laid (Fig. 290). The young lice hatch in the spring and early summer, migrating

Fig. 290.—Cottony maple scale.

at once to the leaves, and there becoming temporarily attached. A number of moults occur while they are on the leaves. Fertilization of females by males occurs here, the impregnated female migrating to the twigs. The following spring the developed eggs cause the body of the female to increase in size. Late in spring and early summer these eggs are laid in the cottony growth above referred to. One female may produce from one thousand to two thousand eggs.

Injury.—This pest is at times injuriously abundant on maples and elms, as well as various shrubs and vines. It may occur on oak, basswood, locust, sumach, woodbine, currant, and other

shrubs. Maple trees in towns and villages are sometimes killed by its attacks (Fig. 289). The English or European sparrows, so abundant everywhere, are disseminators of this scale among shade trees, the young scale being carried on the feet of sparrows, although the active young can crawl from branch to branch.

Fig. 291.—Gipsy moth, female. Natural size. (After Forbush and Fernald.)

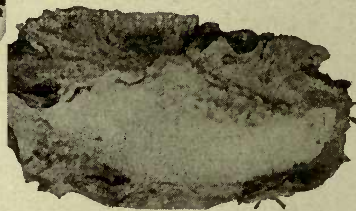


Fig. 292.—Egg cluster of gipsy moth.

Other insects may also be carriers; they may also be carried by infected twigs and leaves blown about by the wind.

Control.—If trees are trimmed in winter and early spring and the cuttings burned, the adult scales on the cuttings and thousands of eggs will be destroyed. Pruning and burning may be done in late summer or fall. Spraying with tobacco extract and soap in spring when young lice are crawling over the branches and leaves will reduce their numbers. Strong caustic sprays in winter when trees are dormant will kill the adult scales. When but few

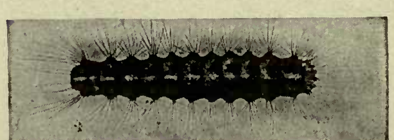


Fig. 293.—Caterpillar of gipsy moth.

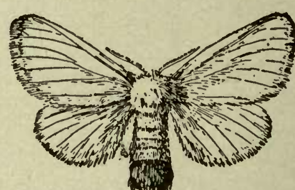


Fig. 294.—Brown-tail moth.

are present on a vine or shrub they may be easily controlled with a bucket sprayer or even killed by touching them with kerosene.

The Gipsy Moth and Brown-tail Moth.—These have become pests of national importance, although at present confined to some of the eastern states. The gipsy moth (*Porthetria dispar* Linn.) was introduced and accidentally distributed about 1868-69. It has now spread over most of New England. The male is brown,

considerably smaller than the female, which is white, its wings marked by delicate, undulating dark lines (Fig. 291). Egg masses (Fig. 292) are deposited in the early summer on bark, fences, stone walls, stone piles, and in similar places. They hatch the following year. The caterpillar is shown in figure 293.

FIG. 295.—Brown-tail moth caterpillar.

FIG. 296.—Egg clusters of brown-tail moth on under side of leaf.

The brown-tail moth (*Euproctris chrysorrhea* Linn.) imported from Europe about twenty-five years later than the gipsy moth, is also well distributed throughout New England. The moths (Fig. 294) are white, with a conspicuous brown tuft on the end of the abdomen. The hairs of the larva (Fig. 295) are barbed, and cause severe irritation when brought in contact with the skin. These moths also lay their eggs in masses (Fig. 296), covering the same with brown hairs, but, unlike the gipsy moth, their eggs hatch the same season and the larvæ live in colonies (Figs. 297 and 298) on leaves, forming a nest of leaves in the fall, in which they pass the winter, completing their development the following year.

Like other introduced species, these insects have increased wonderfully in numbers, and are to-day perhaps the worst insect

FIG. 297.—Winter nest of brown-tail moth caterpillars; a mass of leaves and silk at ends of twigs.

enemy of shade trees. They have, in the New England states, already destroyed millions of dollars' worth of property, defoliating whole tracts of shade trees.

Control.—Arsenate of lead sprays are effective for both of the above insects. In the case of the brown-tail moth the nests should be removed from the trees and burned during late fall and winter. In combating the gipsy moth, traps are employed, such as burlap bands and tanglefoot. Egg clusters may be touched with creosote.

The gipsy moth is particularly dangerous to oaks, willows, and apples. It is a noteworthy fact that the *young* caterpillars will not attack cedars, pines, and hemlocks. While young they

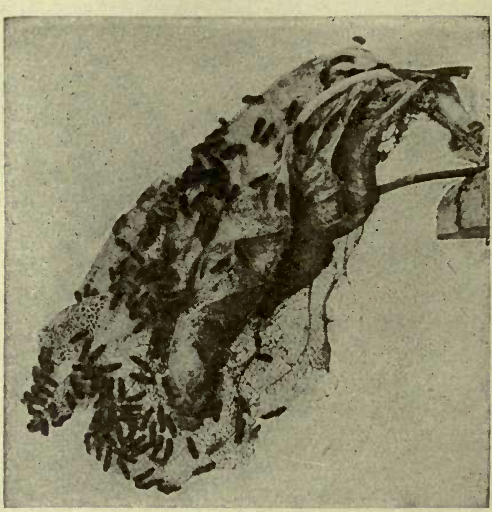


Fig. 298.—Young brown-tail moth caterpillars emerging from winter web and feeding on the dead leaves composing its surface. (After Sanderson.)

have to find deciduous woods. If, therefore, all such are removed from the vicinity of pines, the latter will be protected. Marked progress in combating the gipsy moth is being made along the line of imported parasites.

QUESTIONS

1. Give life history, habits, and methods of control of the box elder bug.
2. Do the same with the bronze birch borer.
3. What is the so-called alder "blight"?
4. Mention some galls of shade trees made by insects, and describe those with which you are familiar. What insect-made galls have you observed on shrubs or other plants?
5. Describe the two willow saw-flies and their larvæ.
6. Give briefly the life history of the white pine weevil.
7. Describe the pine bark aphid.
8. Give life history of the oak pruner.
9. Give description and habits of the mourning-cloak and its larvæ.
10. Give description, life history, habits, and methods of control for the cottony maple scale.
11. Which of the above pests are numerous and destructive in your locality?
12. Describe the work of the gipsy and brown-tailed moths.

CHAPTER XVI

INSECTS AFFECTING MAN AND THE HOUSEHOLD

THIS chapter presents remedies intended to help the housekeeper in her warfare against insect pests, and also deals with those insects or insect-like animals which are directly injurious to mankind, either by causing discomfort and annoyance to man himself, or in being disease carriers.

The Case-making Clothes-Moth.—This widely distributed moth (*Tinea pellionella* Linn.) is grayish yellow in color. The larva or caterpillar, which feeds upon woollens, furs, and feathers, is a dull white with a brown head. The larva is always observed in a "case" made by its weaving together particles from the cloth or other material in which it is working. The head and first segment may be extended from the case. This case, which the larva drags about as it feeds, increases in size as the larva grows. When the caterpillar is full grown the case is fastened to the infested garments by a silken web and the larva changes to a pupa within, the pupal stage lasting about three weeks.

The adult has an irregular flight; it is frequently seen flying in the evening lamp light, but is usually found hiding in dark places among garments, either stored in drawers or hanging in closets. The very minute eggs are placed on the material intended as food for the larvæ.

Control.—A thorough housecleaning once or twice a year does much to keep down pests of this nature. Rugs or carpets should be aired and beaten. Furs kept below forty degrees F. are not injured, and many commercial houses offer opportunities of such storage to their customers. The writer stores what furs and woollens need protecting in summer in a large iron box with a tight cover, and three or four times during the late spring and summer places a few teaspoonfuls of carbon bisulfid in a flat dish on top of the clothing, keeping the box tightly closed during this fumigation. Closets with perfectly tight doors might be utilized in the same way as a chest. Frequently furs, feathers, or valuable woollens are put up in sealed bags made of heavy paper, and repellents such as tobacco, camphor or naphthaline are placed inside. It should be noted that these repellents do not kill, but simply assist, frequently to only a limited degree, in keeping

moths away. They will not drive away the larvæ after they are hatched.

The Webbing Clothes-Moth.—This is a second species of clothes moth (*Tineola bisselliella* Hummel), which is distinguished from the preceding insect by the absence of the larval case. A silken web, however, is spun from the material wherever the larvæ are working. The species generally has two broods. The second brood of larvæ work in the latter part of the hot weather. When the larva is full grown it makes a cocoon of silk or woollen particles and changes to a pupa within.

The measures of control are the same as for the preceding species. Figure 299 illustrates the larva and its moth. Figure 300 is a clothes-moth larva as seen under a microscope.

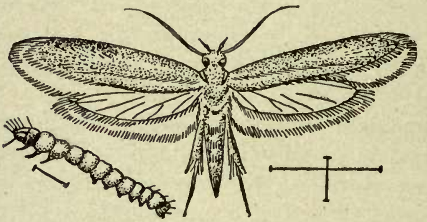


Fig. 299.—Clothes moth, *Tineola bisselliella.* Hair lines indicate exact size. (After Riley.)

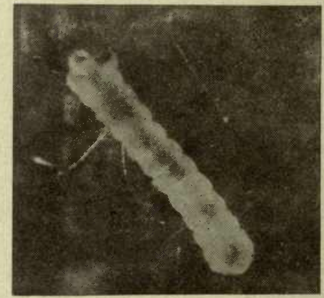


Fig. 300.—Larva of clothes moth. Much enlarged.

The Carpet Beetle, Buffalo Bug, or "Buffalo Moth."—This is a small beetle (*Anthrenus serophulariæ* Linn.), not over a quarter of an inch in length, blackish, with red and white markings. It normally passes the winter under the bark of trees. It finds its way into the house in the spring and deposits its eggs in the carpets or on clothing. Two or three broods occur in a single season. The young grubs are hairy creatures and rejoice in the fanciful name of "buffalo bug" (Fig. 301).

Injury.—In the larval stage injury is caused by their feeding on carpets, clothing, or upholstered articles.

Control.—Once established, this pest is difficult to remove. Infested carpets should be taken up and steamed, the floors cleaned, and the cracks treated with gasoline. If the carpets cannot be removed, use gasoline on the infested parts. The usual precau-

tion against lights being brought near gasoline should be observed. This moth is seldom found in houses with polished floors and removable rugs.

The Black Carpet Beetle.—The habits of the black carpet beetle (*Attagenus piceus* Oliv.) (Fig. 302) are practically the same as those of the preceding species, and its extermination calls for similar treatment.

The Bed-Bug.—This well-known household pest (*Cimex lectularius* Linn.) needs no specific description. Its eggs are deposited in cracks of bedsteads and base boards, sometimes in picture frames and in mattresses. About eight days are required for hatching, and if the young bugs get an abundance of food they

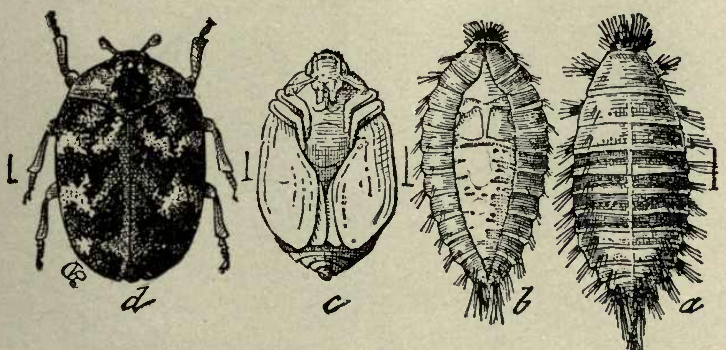


FIG. 301.—The carpet beetle: *a*, larva; *b*, larval skin showing pupa within; *c*, pupa; *d*, adult. (After Riley.)

complete their growth after five moults, becoming adults in about forty-five days. The days are spent in hiding places; at night the young and adults come out to feed (Fig. 303).

Control.—Like other household insects, if once established, bed-bugs are hard to eradicate. Even a most careful housekeeper is liable to find them established in the servants' quarters, if careful supervision is not maintained. Badly infested buildings should be fumigated with hydrocyanic acid gas. This calls for two fumigations at intervals of about twelve days. The author has used this method successfully. Fumigation with sulfur candles is only partially effective. Gasoline may be used freely in every crack where these pests might be expected and in every tuft of the mattress. Special precautions must be taken, in using this agent, against accident by fire. Gasoline might possibly

affect paint and varnishes if used too freely. It will not destroy the eggs; a treatment of gasoline, therefore, should be repeated in about two weeks after the first treatment. A good and very poisonous compound may be made by dissolving two ounces of powdered corrosive sublimate in one pint of water, allowing it to stand two days; then add an equal quantity of alcohol and shake thoroughly. This may be applied with an oil can in every crevice and crack in the bedstead. Kerosene applied in the same way as

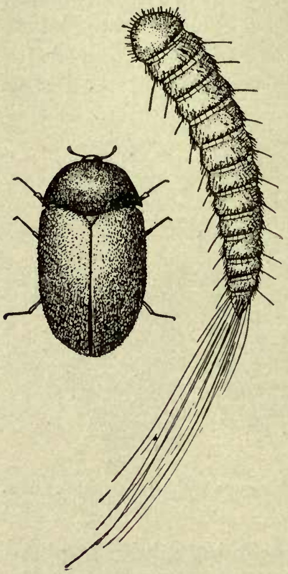


Fig. 302.—Black carpet beetle, larva, and imago. Much enlarged.

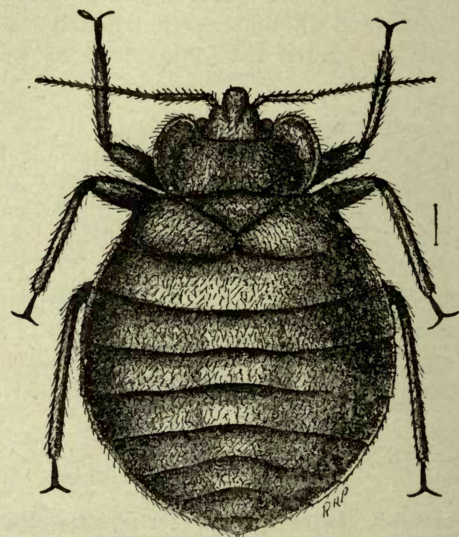


Fig. 303.—The common bed-bug. Much enlarged. (Lugger.)

gasoline is also effective. The bed-bug is capable of going a long time without food.

Crickets (*Gryllus* sp.).—The different species of crickets are almost too common to warrant detailed description. They vary in color from brownish to black, the variation depending upon the species. In the females the ovipositor is as long as, or longer than, the abdomen (Fig. 304).

Injury.—These insects occasionally make their way into the house and become pests. In such cases they eat clothing, especially if it is a little damp, and they also attack foodstuffs. When

they do not cause injury, they are usually welcome, and the chirping of the cricket on the hearth has figured in song and story.

Control.—If they become injurious, pieces of potatoes or carrots thoroughly poisoned with arsenic will make good exterminators. Sweetened and poisoned liquids are also effective, and vessels filled with beer or other liquid placed in localities where they occur make effective traps.

Cockroaches.—These are the well-known Croton bugs (*Blatella germanica* Linn.) found about pantries and kitchens, particularly in the vicinity of the sink. They are light brown or dull yellow. Except in warm buildings, they are dormant during the winter. In the spring the females are observed dragging about their egg

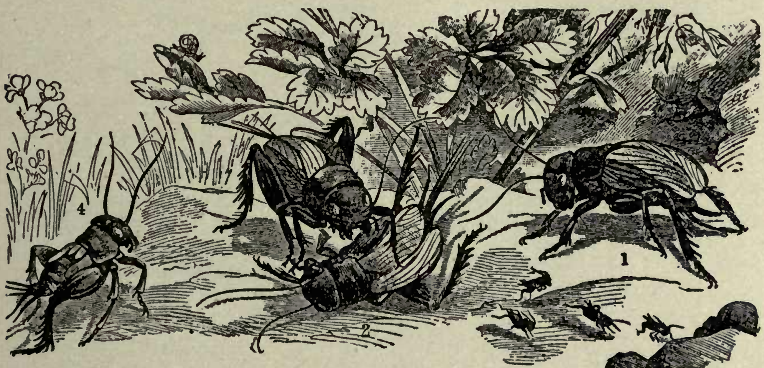


Fig. 304.—Crickets: 1 and 2, adults; 4, nymph. Under 1, crickets just hatched.

cases, these being carried until the eggs are about ready to hatch (Fig. 305). The young grow very slowly and are without wings until late in the fall.

A Serious Pest.—This disgusting pest may be the means of spreading disease, and no good housekeeper will tolerate its presence. It is well to remember that if once allowed to get a start in the house they are extremely difficult to eradicate.

Control.—Where the infestation is very bad, the best remedy is to fumigate with hydrocyanic acid gas if the house stands by itself, so that other households are not involved. Burn sulfur in sealed rooms. This is a desirable method of destroying these insects. It should be repeated frequently for two or three weeks to get lasting effects. Fumigation should take place before egg-laying occurs or after the eggs are hatched. Powdered borax

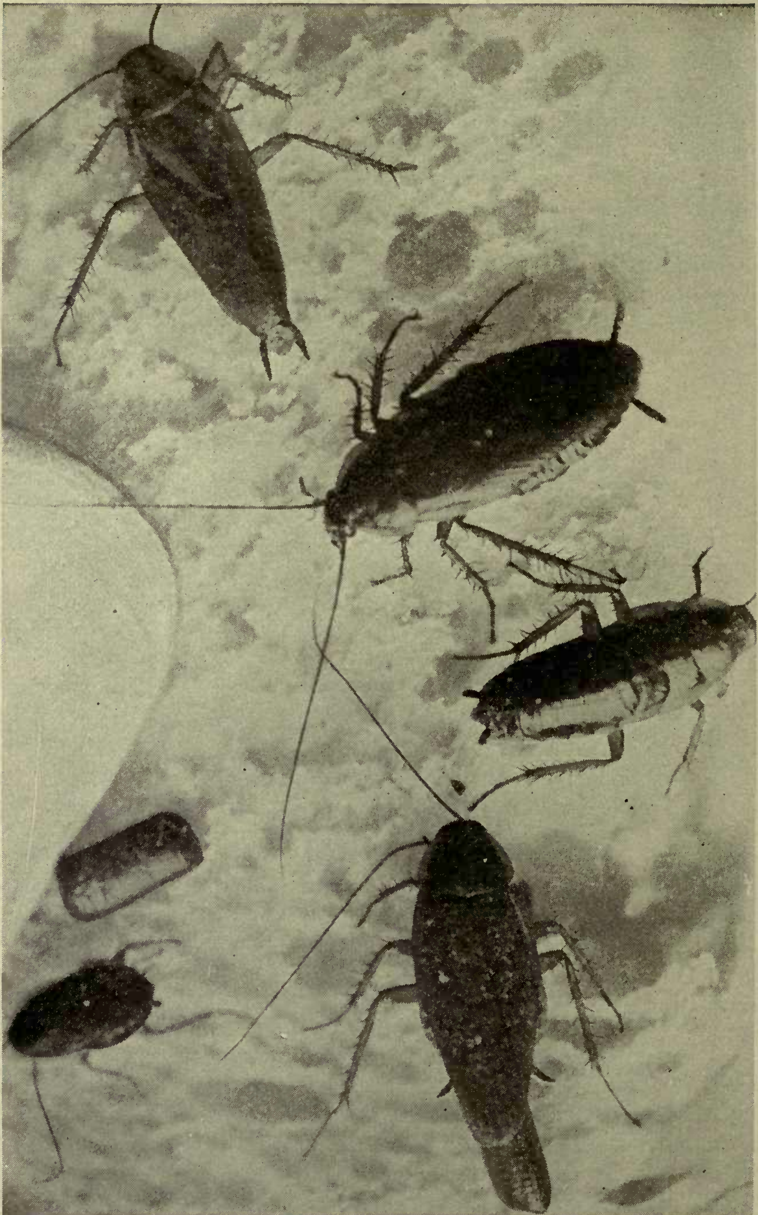


FIG. 305.—Cockroaches. (Original.)

spread along the mop boards of the kitchen and about the sink every night for a week or more has been found efficacious in causing the pests to disappear. One housekeeper also reported success with powdered borax spread on bread or banana and placed where the roaches can feed on this poison. A good bait is made by mixing equal parts of sweet chocolate and powdered borax. This should be scattered where the roaches are plentiful. Several proprietary articles for the control of this insect are on the market, some of

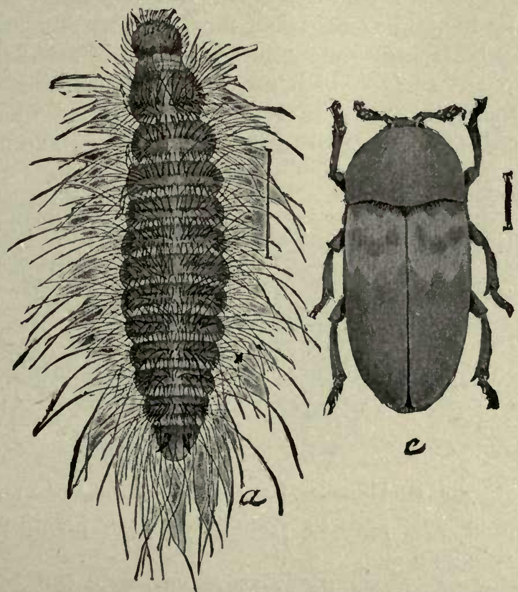


FIG. 306.—The bacon or ham beetle, larva and adult. (U. S. Bu. Ent.)

them being regarded as very good. Where the pest occurs in apartment buildings, the problem of eradication becomes more difficult on account of the easy means of communication between the floors. Cockroaches appear to avoid arsenical poisons. Squirt gasoline behind base boards, in cracks, and all hiding places.

Bacon or Ham Beetle.—This is a stout black beetle (*Dermestes lardarius* Linn.), something less than one-half of an inch long, with a band of grayish-yellow scales covering half the back. The larva is a worm-like grub; when full grown it is brown and hairy (Fig. 306). The adults are found abundantly during early

summer, and if they have access to food, they lay their eggs thereon. Therein the larvæ hatch, feed, and pupate. The pupal stage lasts four, five, or more days. Several broods are possible under favorable conditions.

Injury.—This beetles is frequently attracted to bacon or ham. It is also fond of old cheese. The fatty portion of meat is preferred. The larvæ feed on the surface of the food until time for pupation; then they bury themselves below the surface.

Control.—General cleanliness in housekeeping is desirable. Food may be kept in insect-proof receptacles. An infested piece of meat may be treated by cutting away the infested portion and washing the cut surface with a very dilute solution of carbolic acid. These beetles may be very easily trapped with pieces of meat and old cheese. Badly infested buildings should be thor-

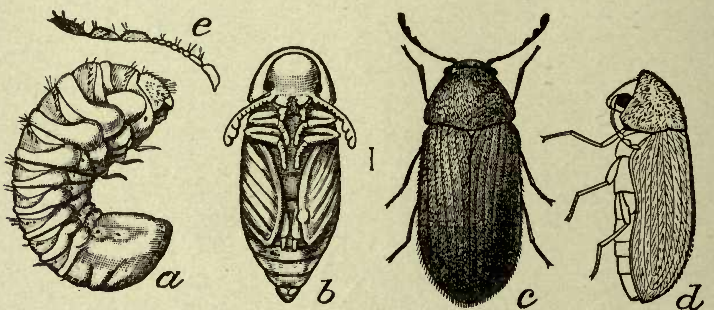


FIG. 307.—The drug store beetle: *a*, larva; *b*, pupa; *c* and *d*, adults. (U. S. Bu. Ent.)

oughly cleaned, and may be fumigated with bisulfid of carbon or hydrocyanic acid gas.

The Drug Store Beetle, or "Death Watch."—This insect (*Sitrodrepa panicea* Linn.), when working in wood, causes a ticking sound which has suggested to the mind of the superstitious the name of "death watch." The beetle is stout, light brown in color, and one-eighth of an inch long. It has a retractile head (Fig. 307). The larva is grub-like and occurs in the same material in which the adults are found.

Injury.—The beetle is practically omnivorous. It is found in mills, granaries, and warehouses, as well as in the dwelling houses. It lives on flour, meal, cereals, condiments, roots, herbs, and animal substances. It has been known to colonize on a human skeleton, dried, with the ligaments attached. It has also been recorded as perforating tin foil or sheet lead.

Control.—Infested material may be heated to 125 or 150 degrees F., allowing sufficient time at this temperature for the heat to penetrate the material. The fumes of carbon bisulfid will also kill the beetle.

The Cigarette Beetle (*Lasioderma serricorne* Fab.).—This is a light brown beetle, one-eighth of an inch long (Fig. 308), which infests tobacco, cigarettes, and a great variety of foodstuffs, as well as condiments, drugs, and dried herbarium specimens.

When abundant and injurious, materials offering it food supply should be kept in insect-proof receptacles. Heat can be used to destroy it, as in the case of the drug store beetle. (See page 221, under Tobacco insects.)

The White-marked Spider Beetle.—This is a small, reddish-brown beetle (*Ptinus fur* Linn.) with four white marks on the wing-

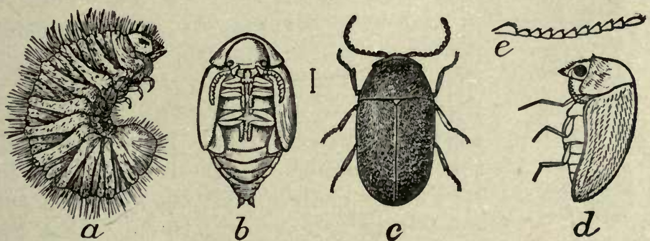


Fig. 308.—The cigarette beetle: *a*, larva; *b*, pupa; *c* and *d*, adults; *e*, antenna. (U. S. Bu. Ent.)

covers. The antennæ or feelers are long, and the legs are long and slender, resembling the legs of a spider. The body is more or less globular.

Injury.—Both the adults and larvæ feed on dried fruits and animal substances, as well as upon cereals, flour, insect collections, dried plants, red pepper, cotton seed, refuse wool, furs, clothing, roots, grains, stuffed animals, etc.

Control.—Infested material may be freed by heat or, if practicable, by fumigation with carbon bisulfid. Museum specimens are generally protected by rendering them inaccessible to the insect. As in the majority of household pests, food material which is left undisturbed for a long time is more likely to be infested.

The Little Red Ant.—The very small red ant (*Monomorium pharaonis* Linn.) (Fig. 309), is rarely found out of doors, but is frequently seen in houses, living in colonies. When found in the house it is extremely troublesome. The life history is, in a general

way, similar to other ants. Probably egg-laying goes on more or less continuously throughout the warm weather. This pest may become a great nuisance through infesting food materials, especially sweets.

Control.—Various methods have been adopted to free a house of this troublesome insect. The writer has destroyed them in a house from which the owners were absent by fumigation with hydrocyanic acid gas. They may be trapped by means of a piece of sponge soaked in sweetened water, these sponges being picked up when full of ants and dropped in boiling water. Scraps of bone or meat may be used in the same way and burned.

A poison solution may be made as follows: Dissolve 5 pounds sugar in 1½ pints of warm water. Add ¼ ounce of sodium arsenite, dissolved in a little hot water. Sponges may be moistened with this solution and placed in cans with holes punched in the lids. The position of these baits should be occasionally changed. This poison is slow in acting. The ants eat it and carry it to the nests, where it is used to feed their young. It is to be noted that this bait would be poisonous to human beings.

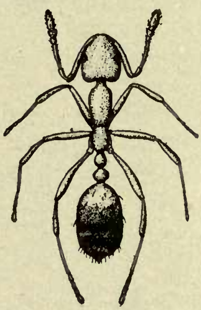


Fig. 309.—The little red ant, house ant, much enlarged.

Pantry shelves painted with a saturated solution of alum appear to defy these insects. Refrigerators, tables, or cabinets may be insulated by placing the legs in dishes and pans of water. As with other ants, for complete relief it is necessary to destroy the egg-producing queens, and if a nest of this species can be found relief can be immediately obtained by squirting kerosene, gasoline, or carbon bisulfid into the nest with an oil can or with a syringe.

"Silver Fish" or **"Fish Moth."**—This is the quick-moving, delicate, wingless, silver-gray insect (*Lepisma saccharina* Linn.), often observed on opening a bureau drawer or in an unused room. When touched it sheds glistening gray scales. It is one-half inch long, the head bearing two long feelers or antennæ. At the posterior end of the insect are three long filaments.

Injury.—The "silver fish," which represents a very low order of insects, lives in dark places among undisturbed books or stored linen or silk or paper, or where any stored substance may be obtained for food. It has been known to completely ruin silk dresses put away for a long period. (See Fig 11, page 15.)

Control.—Frequent handling of the articles liable to attack is the best remedy, for the "silver fish" does not like to be disturbed. Naphthaline crystals scattered about where it may be present form a good preventive. Housecleaning and treatment with gasoline is the best method against infestation. The insect may be poisoned by soaking cardboard in thick flour paste in which Paris green has been mixed, and placing pieces of the cardboard where the insects are most abundant.

Book Lice.—These are wingless insects (*Atropos* sp., and *Clothilla* sp.), almost colorless, very small, and barely evident to the naked eye. They live upon vegetable matter and may be frequently found in books or among starched linens which have been laid away. Also they have been known to occur in great numbers in mattresses stuffed with horse-hair or straw.

Control.—For infestation of mattresses, the only means of control is by destroying the mattress or by fumigating it. Book lice do not ordinarily occur in frequented places, especially if well lighted and ventilated. Thorough scrubbing of woodwork and furniture is desirable. Dust and brush infested bedding and clothing. Supplement the cleaning by applications of gasoline in cracks and crevices not otherwise reached.

The House-Fly or Typhoid Fly.—This common household pest (*Musca domestica* Linn.), it should be noted, never bites. Its food is always taken in a moist condition and is first dissolved by the fly; it rasps the surface with its tongue, pouring out upon it liquid from glands or crop, or both, and after a solution of food is made in this way it sucks it into its crop. This fly is often confused with the stable-fly entering our houses in the late summer or autumn; the latter is capable of stabbing the surface upon which it lies. It must be noted, however, that there are several species of fly resembling house-flies, but smaller.

A Bad Pest.—It is a most disgusting and injurious pest, known to carry germs of typhoid fever, tuberculosis, cholera, dysentery, and probably many other disease germs (Fig. 310). The typhoid germ may live three weeks in the intestine of a fly, and fly-specks are potential breeders of disease. It should be noted that this insect is a conveyor of germs, and not an incubator or secondary host. Germs are picked up in filth and carried to foodstuffs, exposed groceries, and all accessible eatables.

Life History.—The house-fly, by preference, breeds in fresh horse manure, but will lay its eggs in any form of filth: human

excrement, spittoons, decaying vegetable matter, and garbage of all sorts. Eggs are deposited in groups of 100 or more, and the female may lay several groups of eggs before dying. These eggs hatch in twenty-four or more hours, depending upon temperature. The maggot stage lasts a week, and the pupal stage also about a weeks. Adults (Fig. 311) may differ in size, due possibly to a difference in kind and quality of food supply. It is estimated that one pound of horse manure will produce 1200 flies. The house-fly cannot fly a long distance, but it is carried passively on street cars,

FIG. 310.—Petri dish containing agar over which a fly was allowed to walk. White spots are colonies of bacteria coming from germs left by the fly when crawling over the jelly.

horse vehicles, on trains, ships, delivery wagons, and by other means, and, once started in a community previously free, it soon is present in enormous quantities. In fact, so rapid is its increase that it is estimated that during a season enough flies arise from the batches of eggs laid by one mother, supposing all to live, to bury the entire earth four to seven feet deep. Putting it in different words, enough descendants would come from the laying of one mother during the course of a season to go around the earth at the equator, if placed end to end, many times. The length of life of the adult fly cannot be stated with absolute accuracy. It may live three weeks or longer.

Control.—It is evident from the above that all breeding places and all accumulations of filth should be removed at least once a week. Manure piles should not be allowed to accumulate behind livery stables or private barns. Prompt disposal of garbage should be regulated by law, and communities should be instructed as to the dangers arising from toleration of the house-fly, and in methods leading to relief. Trapping flies is only a minor method of treatment. Energy should be bent more particularly upon cleaning up

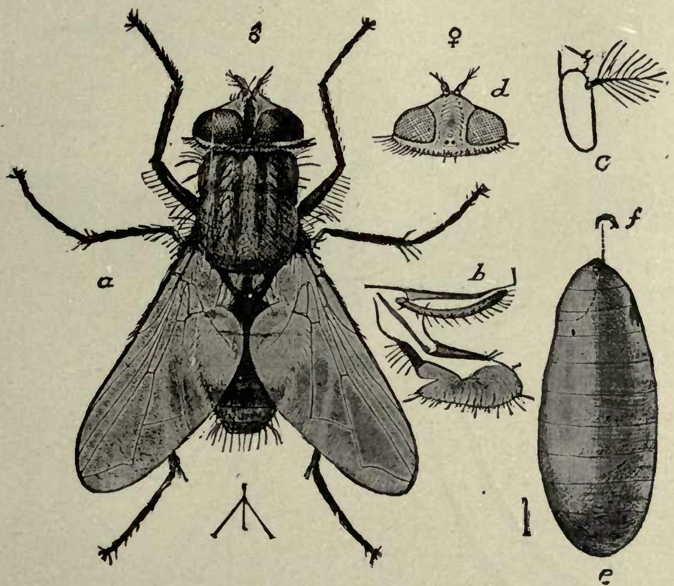


Fig. 311.—The house fly: *a*, adult male; *b*, proboscis and pulp of same; *c*, terminal joints of antennæ; *d*, head of female; *e*, puparum; *f*, anterior spiracle. All much enlarged. (After L. O. Howard, U. S. Bu. Ent.)

the neighborhood. Where imperative, sticky fly-paper is more advisable than poison fly-paper. Flies may be poisoned by placing in likely places shallow plates containing a solution made by pouring three teaspoonfuls of formalin into a half-pint of water to which one-half pint of milk has been added. Houses and porches should be screened in the summer. For very evident reasons, a house should not be located near a stable. The use of house toilets with sewage connection or cesspools is evidently much more desirable than conveniences frequently prevailing in the country. The open privy is a menace in connection with the house-fly.

Mosquitoes.—There are a large number of species of mosquitoes in the United States; the two most dangerous are Anopheles (Fig. 312), a particular species of which is an intermediary host for the germ of malaria; and Stegomyia, dangerous because it spreads yellow fever (Fig. 313). The first-named genus is sometimes found in localities where malaria does not exist, and under those conditions, of course, it is not a dangerous insect. However, all mosquitoes are annoying, and, although the male is innocuous, since

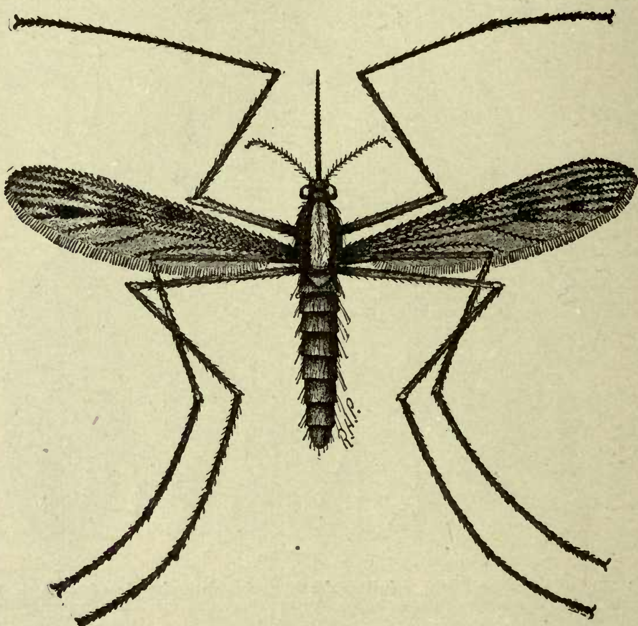


Fig. 312.—The malaria-bearing mosquito. (Lugger.)

it does not bite, the female mosquito is the cause of many wakeful hours. It is also of commercial importance in certain sections, in that it seriously affects the condition of stock and milk cattle. Out-of-door occupations and pleasures in some localities are impossible during the summer on account of the presence of this pest.

Life History.—While details of life histories vary strikingly, there being marked differences in the length of life cycles, in a general way we may include all species in making the statement

that adults and immature forms pass the winter in moist places or even in ice. In the spring, when the ice melts, the transformation is completed and the females soon lay eggs and die. These eggs are placed either on the surface of small, shallow pools or depressions which hold a little water, or upon moist places where the insect instinctively realizes that water will shortly be present. It is a significant fact that a couple of tablespoonfuls of water overlooked in a tin can or broken pitcher hidden under the side-

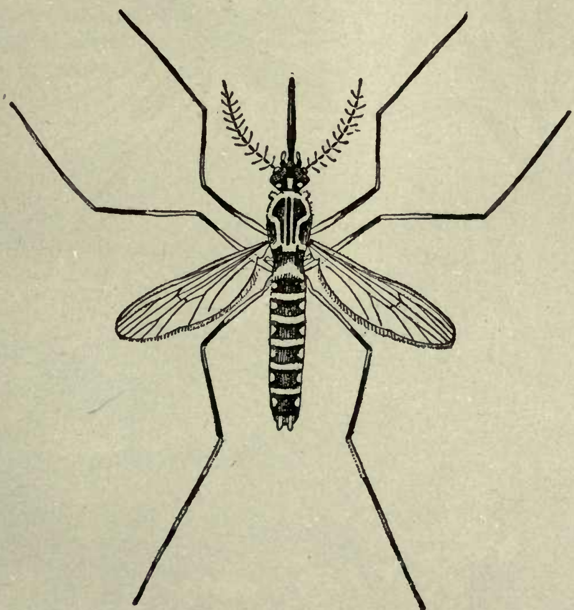


Fig. 313.—The yellow fever mosquito, female. (After L. O. Howard.)

walk or under shrubbery will, if the water remains for eleven or twelve days, be sufficient to give rise to a hundred or more of these troublesome insects. In a general way it may be said that the life cycle from egg to adult is about two weeks (Figs. 314 and 315). Probably the normal food of mosquitoes was originally the juices of tender plants, and it is very evident that comparatively few of their numbers ever have a chance to feed on man or warm-blooded animals.

Three Groups of Mosquitoes.—In the case of the yellow fever mosquito (*Stegomyia calopus*), which is a rather small species, with

white and black markings, the eggs are laid singly, and not laid in raft-shaped masses, as in the case of the common species of "house mosquito" (*Culex pipiens*). They may be placed in dry situations which will receive water later.

FIG. 314.—The life history of mosquitoes: *a*, larva; *b*, pupa; *c*, adult leaving pupal skin; *d*, female depositing eggs; *e*, male. Greatly enlarged. (After Brehm.)

The adult Anopheles is frequently found in latitudes far north of the malarial zone, and is not uncommon in states as far north as Minnesota. It is long and slender with wings generally spotted. When it is at rest, or biting, unlike the common "house mosquito," it elevates the posterior part of its body, causing beak and body to be in an almost straight line. The eggs are laid, singly or in small groups.

The larva, unlike that of *Culex* or *Stegomyia*, is depressed, with a small head, and lies on the surface of the water. Its breathing tube is very short, and its food consists of organisms on or near the surface. The species of Anopheles known to be dangerous as a malarial carrier is *A. maculipennis* Say. Other species may be found to be equally dangerous.

Control.—That oil of citronella applied without dilution to the back of the neck, face, hands, and wrists upon entering infested localities is fairly effective so long as it lasts, is not fanciful, and it is one of the best repellents. Care should be taken not to allow citronella to come in contact with one's eyes. The same substance mixed with vaseline is more lasting in its effect. Windows and

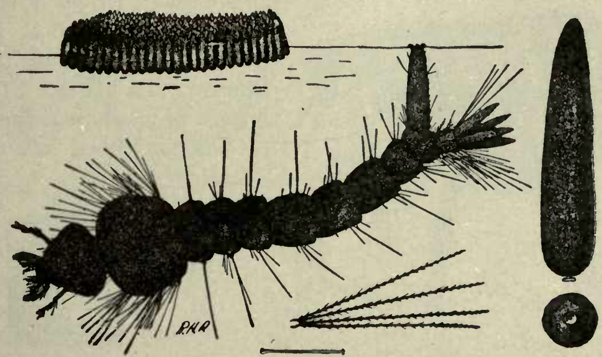
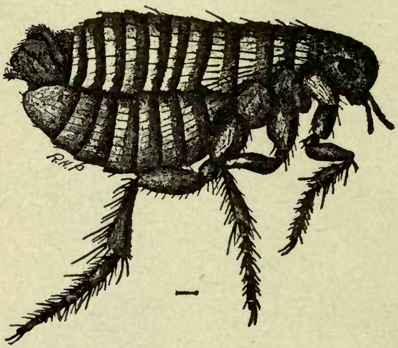


FIG. 315.—Mosquito larva, showing breathing tube, also egg mass, and single egg, all much enlarged. (Lugger.)

doors and porches of houses should be thoroughly screened in summer; all tanks or rain barrels should be either screened or treated with kerosene oil. Put a thin film on the surface. Tin cans, broken dishes, etc., which hold water should not be allowed to accumulate in rubbish piles or elsewhere. Eavestroughs dammed by leaves and twigs form good breeding places, as do also tracks of stock around drinking troughs or small indentations along the shore of pond or lake, as well as the drain ditches in the fields where water stands. Standing water in ditches or pools suggests the following methods of treatment. The water may be drained away, or a film of kerosene may be sprayed or allowed to flow over the surface. Depressions may be filled with earth. Small fish may be introduced into ponds, since the latter prey upon immature forms of mosquitoes. Rooms may be freed by

moistening pyrethrum powder and moulding the same into a cone the size of a chocolate drop, allowing it to dry and applying a match to the apex of the cone. This stupefies or repels the mosquitoes, although it may not kill them. Affected mosquitoes should be swept up and burned. Chinese "joss sticks" burned in sleeping rooms act as repellents.

House Fleas.—Where cats or dogs are kept or have been kept, the household is apt to be troubled by one or both of these insect pests (*Pulex irritans* L. and *Ctenocephalus canis* Curtis). They are almost too well known to need description. The first-named species is common throughout Europe and quite plentiful in California, and it also occurs in localities in the Middle West. The last named, which is the common cat or dog flea, is more common in the house than the human flea (Fig. 316). A house which has lodged a cat or dog and been left unoccupied for a time may become badly infested. One can hardly realize the unending appetites and activity of these insects unless he has suffered therefrom.



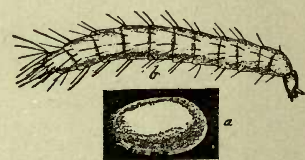


FIG. 316.—At left, human flea, greatly enlarged. At right, egg (*a*) and larva (*b*) of dog and cat flea, much enlarged. (Lugger.)

Life History.—The female deposits, on an average, eight hundred eggs during its lifetime, laying from twelve to twenty at one time. These are placed in cracks of floors, dark corners, or where dead organic matter is left undisturbed for a time. In warm weather they hatch in about six days. The white larvæ have antennæ or feelers but no eyes, which is unusual for immature forms of insects. They soon become yellowish, later brownish, and reach full growth in eleven days, thereupon forming a loose cocoon of dust, etc., in which they transform to pupa. The adult appears in from ten to twelve days. Several broods occur during the warm weather.

Control.—Where cats and dogs are absent there is not much danger of serious trouble. If pets are kept, a rug or mat should be provided for the animal to sleep on, and this should be given frequent shakings and brushings. Bedding where pets have slept which is suspected of harboring these insects should be burned. In badly infested houses where carpets are used, these should be taken up and the floors washed thoroughly with hot soapsuds, the cracks being sprayed with gasoline or kerosene. General cleanliness, thorough ventilation of rooms, and the use of insect powder, repeated if necessary, as well as the use of the vacuum cleaner, all tend to keep down this pest. Rugs are always preferable to carpets in a house, for evident reasons. Upon the cat or dog itself pyrethrum powder may be used, rubbing it

FIG. 317.—The irritating harvest mite, or "jigger," on right. The American harvest mite on left. Greatly enlarged. (After Riley.)

into the hairs of the animal. Bathing with a solution of creolin according to directions on bottles is a means of killing the pests and is, for a time, repelling.

The Harvest Mite, or "Jigger."—This is an eight-legged animal when mature. It has only six legs during the larval stage, but is not a true insect. It is frequently called "jigger" or "chigger," and was given the name of "*Leptus irritans*" by Riley. Its life history is at present a matter of investigation. It lives on low vegetation in more or less wooded areas, and must be dependent upon vegetable tissues, although plants are forsaken immediately for a warm-blooded animal when opportunity affords. This mite (Fig. 317) is not to be confounded with the so-called "jigger flea" or "chigoe" (*Sarcopsylla penetrans* Linn.), the female of which burrows into the flesh of the host.

Injury.—These minute pests bore into the skin of human beings, causing, about twenty-four hours after the attack, intense itching at the point of infestation, which point is marked by a red patch varying from the size of a dime to that of a quarter of a dollar. Sometimes the itching is almost intolerable, and it may last several days.

Control.—Itching may sometimes be allayed by applying at the very first appearance moderately strong ammonia. Another application is a super-saturated solution of baking soda. If one suspects that he has been exposed to the attacks of this pest, an immediate hot bath with an abundance of soap and a change of all clothing will frequently ward off a disagreeable experience. These pests prefer shady localities, and in proportion as undergrowth and weeds are cleared off and sunshine allowed to penetrate, the pest disappears. Application of kerosene to low shrubbery along the edge of woods in parks or private grounds will lessen the evil. The dusting of Persian insect powder or powdered sulfur in the stockings and under waist-band when on the point of entering infested locations will do much to prevent attack.

The Confused Flour Beetle (*Tribolium confusum* Duv.).—This small pest occasionally finds its way into the household, causing much annoyance to the housekeeper. The source should be sought with the grocer, who, in turn, should seek it in the mill or warehouse from which infested flour was obtained. The beetle is a slender, brownish insect, not more than one-eighth of an inch long. It may become a general pest, although originally found in flour.

Control.—Housekeepers suffering in this connection are advised to make complaint at once to the parties selling them infested flour. At the same time it should be noted that if the flour bin is not cleaned, but flour added from time to time, as the supply gets low, a pantry or house may be overrun, because of the opportunity for the insect to increase in the lower part of the flour bin from the original supply. (See page 349.)

Buffalo Gnats or Black Flies.—These insects are short, with a bulging thorax and broad, short wings (Fig. 318). They are active until sundown, at which time mosquitoes take their place as annoyers of mankind and stock. Only the females suck blood. The eggs are deposited on stones or projecting parts of submerged objects in running water. The larvæ live in the swift current, feeding on small aquatic animals. They are equipped with pecu-

liar, fan-shaped structures on the head which create currents of water towards the mouth. They may securely anchor themselves by a sucking disk and a tough silken thread. An upright position is maintained in the water, and locomotion is performed after the manner of that of the measuring worms. When full grown the larvæ pupate by making small, cradle-like structures on the sides of stones. From these cradles the adults emerge, coming to the surface like corks and running ashore to complete their final hardening. A visit to the north woods in June and July is rendered extremely disagreeable to most of us on account of their activities.

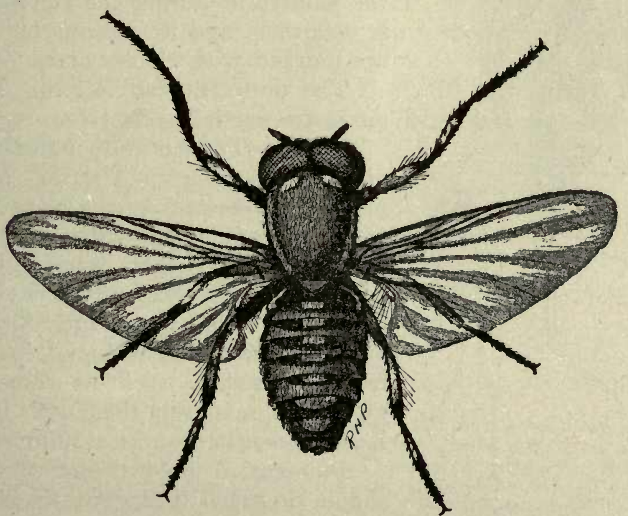


Fig. 318.—A species of black fly, *S. venustrum*. Much enlarged. (Lugger.)

Injury.—Black flies at times make life unbearable for both man and beast, in both the North and the South, where running streams are numerous. Man is attacked along the edges of his hair, on his neck, about his eyes, ears, and wrists—anywhere where hair is short. These insects readily draw blood and appear to inject a poison, as severe attacks cause marked symptoms of poisoning. As intimated above, they are most active, and their attacks are most severe on warm, sunshiny days. Figure 318 illustrates one of the species, *Simulium venustum* Say.

Control.—Rubbish should be removed from streams where practicable. Repellent substances may be used upon exposed

surfaces of human beings and animals. Among these are oil of tar and pennyroyal, citronella, citronella mixed with vaseline, and the various "fly dopes" which are advertised for this purpose. Smudges of smoke are good protection for animals and sometimes are used about the camp. Pyrethrum powder burned upon pieces of bark in the house or in a tent will kill or drive away black flies.

The "No-see-um," or "Punkie."—This tiny speck of a fly (Fig. 319) (*Creptopogon* sp.), barely visible to the naked eye, and capable of getting through the finest netting, is frequently a great tormentor of human beings who visit the wilderness during the summer. It is yellowish, and its transparent wings are marked with cloudy areas.

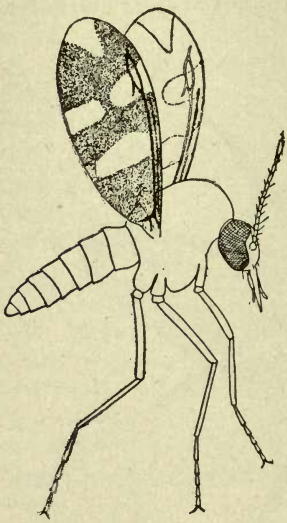


Fig. 319.—"No-see-um," "punkie." Greatly enlarged. (Lugger.)

The ointments advised for buffalo gnats are partially effective.

Mites.—These minute animals (*Carpoglyphus passularum* Herring) are not insects, but belong to the class *Arachnida* and order *Acarina.* Unlike insects, they have four pairs of legs in the adult stage. Originally an European species, this has been introduced on our west coast. It is found in stored fruits, especially such as come from California, rendering them unfit for use; it is frequently found in California figs.

Fumigation under proper conditions should do much to destroy these pests. (See discussion of fumigation.)

Wood Ticks.—Several species of ticks other than the two known fever-bearing forms are found in the United States. Many of these attack man, and practically all of them cause irritations and sores. Sometimes serious inflammation is caused where they attach themselves to human beings. They are often found attacking dogs, rabbits and other animals. The female ticks, which have strong hooks at the end of the rostrum with which they anchor themselves to the flesh, are the dangerous individuals. They become engorged with the blood of the host and finally drop from a rabbit or dog, as the case may be, and lay their eggs on the ground.

Control.—No absolutely effective method of control is available.

During that part of the summer season when wood ticks are abundant, careful scrutiny of body and clothing should be made on the part of those exposed to their attacks. The pests should be picked off and destroyed before they have an opportunity to cause a painful sore by becoming firmly attached. The author knows, from personal experience, that ticks brought into the house on clothing may fasten themselves to the skin days after this occurs. Since these ticks are found on the top of low vegetation growing in or near wooded areas, awaiting their victims, the avoidance of such situations during the tick season would be a safeguard.

QUESTIONS

1. Give description and habits of the two clothes moths, comparing their work.
2. What are the methods of preventing the attack of clothes moths and of eradicating them in furs or woollens?
3. Discuss the value of moth balls and napthalene in controlling insects.
4. What are the habits of and control measures for cockroaches?
5. Discuss the carpet beetle or "buffalo bug," giving remedial measures?
6. Give life history and methods of control of bed-bugs.
7. What are the habits of the little red ant occurring in houses? What are the best remedial measures?
8. What injuries are caused by the "silver fish"? How is it controlled?
9. Discuss at length habits and life history of the house-fly.
10. What precautions should be taken to lessen the house-fly evil—(*a*) by the householder, (*b*) by towns or cities?
11. Give life history and habits of mosquitoes in general. Are any of them a menace to health?
12. What precautions should be taken to lessen the number of mosquitoes?
13. Under what conditions may we expect to find a house overrun with fleas?
14. Enumerate all precautions necessary to prevent infestation of a dwelling by fleas, and state how animals may be relieved of this pest.
15. Discuss life history and habits of black flies or buffalo gnats.
16. How do wood ticks affect man and animals, and what can you say as to methods of control?
17. What household pests have you found troublesome in your own experience?

CHAPTER XVII

INSECTS AND INSECT-LIKE ANIMALS ATTACKING STOCK AND POULTRY

Livestock, including poultry, forms one of our most valuable assets. Milk supply and beef production fall off frequently, through insect attack, and the egg supply and health of chickens are largely dependent upon the absence of vermin in the hen-house and nests. This chapter deals with the pests directly concerned with these conditions.

The Horse Bot-Fly.—One of the most interesting and most injurious of insects is the horse bot-fly (*Gastrophilus equi* Fab.).

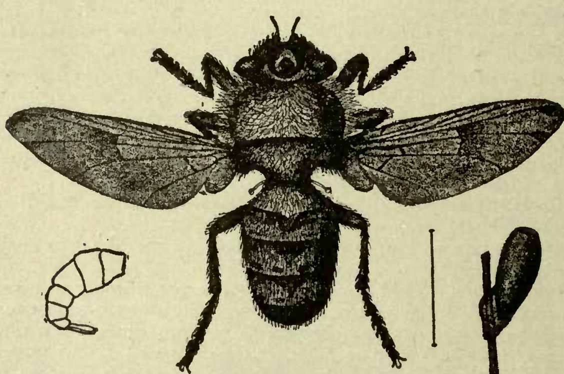


Fig. 320.—Bot-fly of horse, much enlarged. (Lugger.)

The female lays from four hundred to five hundred eggs, all of which may be placed, under favorable circumstances, upon one horse. These eggs are fastened to the hairs, generally of the fore-legs, shoulders, or chest. A horse instinctively fears this pest and will often be seen when in the pasture, to start and strike with the fore-feet, although the cause of its nervousness is not visible. The adult fly is brownish, more or less hairy, and looks a little like a small honey bee (Fig. 320). It is most skilful in depositing its yellowish eggs, or "nits" as we sometimes call them, on the animal's hairs (Fig. 321).

Eggs and Larvæ.—The moisture and friction which these receive from the animal licking its hair cause them to hatch, and further licking, occasioned possibly by the irritation of the skin caused by the presence of the tiny larvæ, carries the maggot into the mouth. It finds its way into the horse's stomach, and there completes its larval life, attached to the lining of the stomach. It is sometimes so abundant as to completely cover a portion of the stomach (Fig. 322). Normally the egg stage lasts about fifteen days. Evidently, if the eggs go four weeks without being licked, a very small percentage, if any, of them will hatch. The bots live in the stomach or intestines eight or ten months, moulting twice during that period.

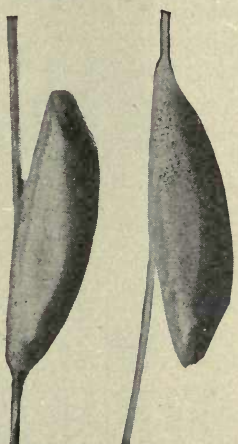


Fig. 321.—Eggs of horse bot-fly, attached to hairs. Greatly enlarged.

Injury. — Naturally, when numerous, they sap the vitality of the horse. They also cause great irritation by attaching themselves to the lining of the small intestines and the rectum. City horses, whose droppings fall mostly on pavements and in other places unfavorable for the development of the bots, are not so subject to the pest as are the animals in the country.

The Next Season.—In the spring these bots loosen their hold and pass out with the droppings; they work their way into the soil an inch or two, or into some protected locality; each "bot" or larva changes to a pupa, lying within a pupal case, from which the adult fly emerges after about thirty days.

Control.—A horse will not be attacked so long as he is in the stable. Ordinarily a stable horse can be kept free of what few "nits" it attracts, while out of doors, by proper currying, and no careful man in charge of horses will allow the eggs to remain on the animal or animals in his charge. Horses in pasture and not being groomed frequently become covered with eggs during summer and early fall, and such animals should be carefully examined every two weeks and all "nits" removed. The eggs can be cut off or killed by a trace of kerosene—just brush them over with a feather wet in the oil and do not use enough kerosene to injure the hide. Or they may be killed by the use of a wash consisting of one part of carbolic acid in thirty parts of water. We can resort to clipping when eggs are deposited in numbers. The eggs may

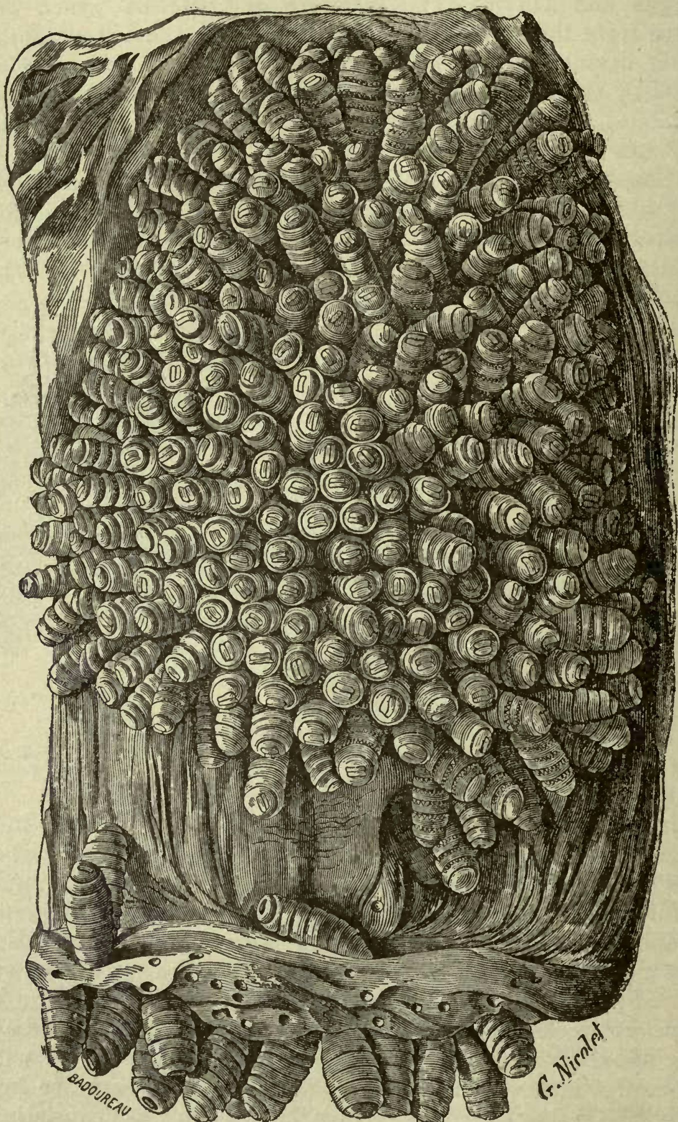


Fig. 322.—Bots in stomach of horse. Natural size. (After Heller.)

be destroyed by the use of a sharp razor without cutting much of the hair. A thoughtful teamster in a field or elsewhere, if he observes a bot-fly disturbing his horses, will try to kill the fly with his hat or in some other way, and thus prevent further trouble.

The United States Department of Agriculture has in the past suggested the advisability of treating piles of dung by some process which will destroy the bot. It is very evident that so long as the horse is kept from licking his coat where eggs or larvæ are, no harm can befall him other than the irritation caused by the attacks of the fly.

Internal Treatments.—A horse in poor condition, in whose droppings the owner occasionally notices bots, is probably badly enough affected to call for treatment, and a veterinarian should be consulted. Sometimes turpentine is used internally, but it is a dangerous remedy in the hands of the uninitiated. Four-ounce doses of turpentine, four hours apart until three or four doses have been given, the last dose followed by one ounce of powdered aloes, have been recommended. Carbon bisulfid has also been used in Italy with marked success. Six gelatine capsules, each containing fifteen grams of this liquid, were given to two horses at intervals of two hours. During the four following days the first horse passed 497 bots; the second, in five days, passed 571 bots. Another party gave one horse thirty-two grams in five hours, and the animal later passed 203 bots. Horses so treated should be carefully watched, and if any bad effects result the treatment should be stopped. We are not aware that this treatment has been used in this country. The old and absurd "molasses and milk" remedy has long since been found to be absolutely of no use.

Red-tailed Bot-Fly.—This is another bot-fly (*G. hæmorroidalis* Linn.), occuring in some localities, which attacks horses. Its habits are much like those of the species just described, and the same remedial measures will apply. It is claimed that the female deposits her eggs close to the mouth of the horse instead of on its shoulders and fore-legs (Fig. 323).

Another Important Bot-Fly.—With habits somewhat like the two preceding, this species (*G. nasalis* Linn.) was formerly believed to prefer the region near the nose or "chin" for egg-laying, but it is now said to oviposit on hairs. Horses seriously affected with this bot should receive the attention of a good veterinarian.

Control.—The means of prevention are practically the same as in the first-described species, *G. equi*. Touching the eggs every

few days, when a horse has been exposed, with pure kerosene might prove efficacious, but a mere combing or use of a brush is not sufficient with this bot, or with any other laying eggs on the hairs. Repulsive ointments on the lips or nose would be of service where the animals are running in pasture.

Ox Bot-Flies, Warble Flies.—The genus *Hypoderma* includes species of bot-flies which make tumors on cattle. Recent investigators question the accuracy of the following hitherto accepted method of entering the animal. Like other bot-flies, they lay eggs on the hairs in spring and summer, and these eggs are either hatched by the

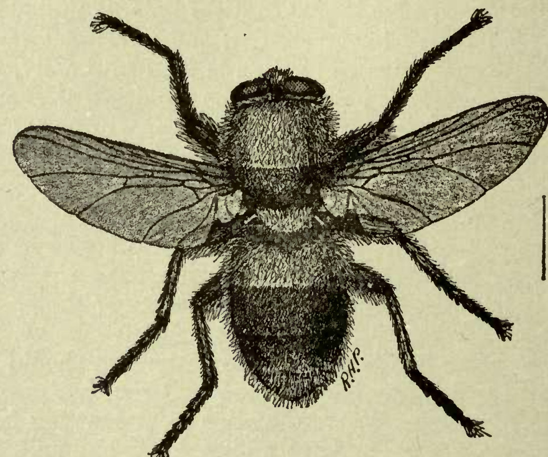


Fig. 323.—Red-tailed bot-fly. Greatly enlarged. (Lugger.)

moist friction of the tongue of the animal—the tiny maggots finding their way into the mouth by subsequent licking—or the eggs themselves are carried into the mouth and hatch there. In either event, the young maggots migrate down the gullet, through its walls and other tissues of the victim until they reach the skin, where they appear, forming the swellings known as "warbles." These become more noticeable in midwinter and later. Here they mature, in tumors caused by their own activities. Their anterior end, with its mouth, is at the bottom of the tumor, where the mucus upon which they feed gathers. The posterior end, through which most of the breathing takes place, is directed upward. This is near the small opening in the hide, which is appar-

ently made for the purpose of respiration, discharge of excrementitious matter, and the final escape of the bot (Fig. 324).

Injury.—The bot or larval stage lasts for nine or ten months, and the vital activities of the bot, if abundant, cause the victim to lose flesh, to fall off in milk—if it is a milch cow—and impart to the flesh in the vicinity of its work a slimy, greenish appearance. This abnormal flesh is called "licked beef" by butchers.

When mature, the bots force their way through the hide and, dropping to the ground, bore an inch or so into the soil, turn into pupæ, and after about four weeks in the pupal stage emerge as perfect flies. Until 1890 it was supposed that the eggs were laid on the back of the animal, and that the maggots penetrated the skin at that place.

Two Species Confused.—*Hypoderma bovis* De Geer is the most commonly described ox-warble fly, but it is doubtful whether

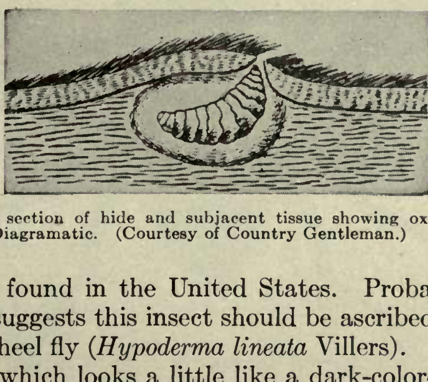


Fig. 324.—Vertical section of hide and subjacent tissue showing ox warble in position. Diagramatic. (Courtesy of Country Gentleman.)

this species is found in the United States. Probably the injury to stock that suggests this insect should be ascribed to the striped warble fly, or heel fly (*Hypoderma lineata* Villers). This is a hairy fly (Fig. 325) which looks a little like a dark-colored bee. There are yellowish-white hairs on the thorax, while above, the abdomen is banded with black and whitish color. Four lines on the thorax give it its name, the striped warble fly. The name "heel fly" comes, according to the statement of cattle men in the Southwest, from the fact that it lays many eggs on the heels of the cattle, above the hoofs. The eggs are attached to the hairs by a peculiar clasping apparatus at one end.

Control.—These tumors may be easily detected, when present, by running the hand over the back of an animal. The bot may be squeezed out of the tumors on the back of milch cows and killed. To do this, enlarge the opening a trifle, if necessary, with a clean knife. This squeezing out of the bots causes some pain, as is

evidenced by the cattle wincing during the operation (Fig. 326). Or introduce a drop of kerosene or a little mercurial ointment through the opening of each tumor. After the bots have been removed or killed within the tumors, the latter should be dressed a few times with vaseline in which carbolic acid has been mixed, or with some other ointment or sterilizing material. A mixture of one quart of powdered sulfur and four parts lard, rubbed into and over openings of tumors, will kill the bots.

Repellent Materials.—If the eggs on the hairs are moistened with kerosene when first observed, they will not hatch. It is not

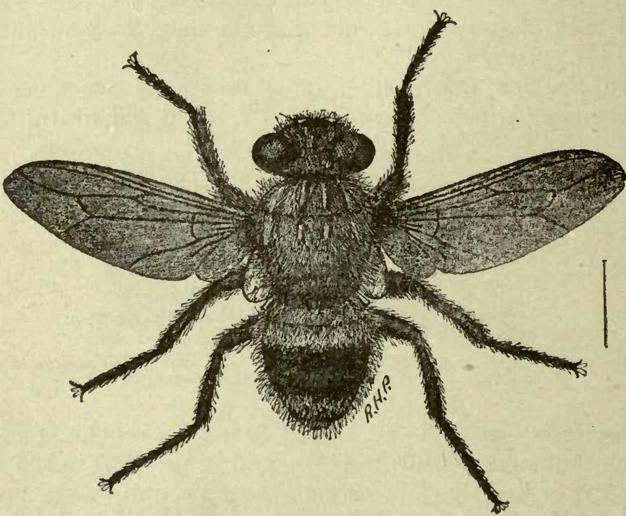


Fig. 325.—Striped warble-fly or heel fly. Natural size shown by hair line on right. (Lugger.)

safe to use too much kerosene. Repellent materials, which are persistently sticky, such as fish oil, or a compound of pine tar and kerosene and fish oil, may be frequently smeared over the back, sides, belly, fore-legs, and roots of the tail of stock running in pasture. This will in a great measure reduce the evil. This is not always practicable. Of course, the flies will find some animal poorly protected, and this animal will suffer all the more on account of the protected condition of its mates. Fish-oil emulsion, first used against the horn fly, might well be used on stock running in pasture, both for the ox-warble and the horse bot-fly. It is inex-

pensive and easily applied, and those who have worked with it claim that its effects will last for four or five days. If the animals are enclosed and a knapsack sprayer used, a large number of cattle may be treated in an hour. The emulsion is made as follows: Dissolve one-half pound of common hard soap in one gallon of boiling water; add gradually two gallons of fish oil; churn the liquid through a force pump for several minutes; when wanted for use, dilute by adding fifteen or twenty parts of water to one part of stock solution. The United States Department of Agriculture has recommended tar, or the following mixture: Sulfur, four ounces; spirits of tar, one gill; whale oil, one quart; one application each week.

Naturally, housed animals are not so subject to attack, and if animals in pasture can resort to a shed, to deep shade, or to water, they are much less troubled than those not so protected. Those in charge of milch cows or other cattle kept in barns should be on the lookout at the proper time for bots among them or eggs on the hairs. When seen, prompt measures should be used. Coöperation is absolutely essential, in this as in other farm practices against insects, to insure the best results.

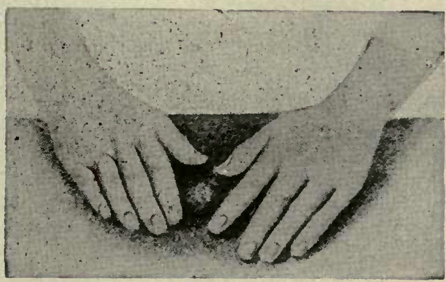


Fig. 326.—Method of squeezing out "grub" or bot. (Courtesy of Country Gentleman.)

The Screw Worm.—This is one of the most injurious of the flesh flies (*Chrysomyia macellaria* Fab.). It is bright metallic green, with prominent, dull-red eyes, and is a little larger than the house-fly. The back is marked with three distinct black stripes running from head to abdomen (Fig. 327). The larva or maggot is similar to other maggots, but has a ring of bristles between each pair of segments, from which it obtains the name of screw worm. These bristles act as legs in locomotion. The mature maggot is three-fourths to one inch long, and the mouth parts are represented by two pointed black hooks.

Life History.—The adult female lays an enormous number of eggs on or near dead animals or in open sores of living animals. These eggs hatch in from one to two days, and the maggot attains

full size in about a week. Pupation takes place in the ground. The reddish-brown pupa is one-third of an inch long. After about a week in the pupal stage, the insect emerges as an adult.

Injury.—Since these insects fly from dead matter to parts of living animals, including man, dogs, sheep, cattle, horses, etc., it is evident that a wound can be very seriously poisoned. In consequence, great pain and even death may be caused by the attacks of this fly. Human beings with severe colds are sometimes attacked, flies depositing their eggs in the nostrils. The author has seen maggots of this species removed from a baby's hand upon which had been placed sweet oil. The maggots force their way

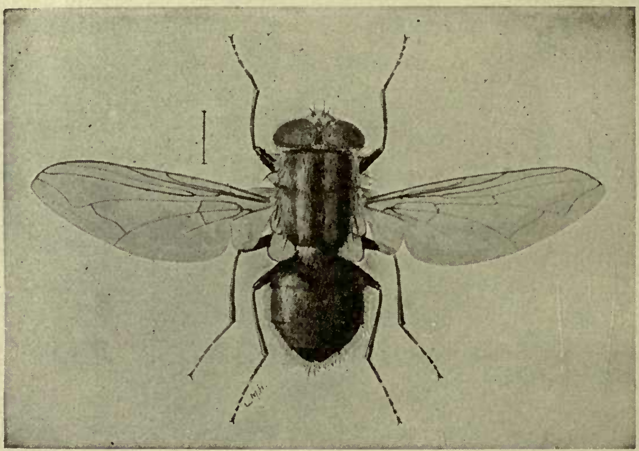


FIG. 327.—The screw-worm fly, enlarged. (Lugger.)

into the flesh, feeding voraciously, and thus enlarging the sores. The animal attacked is soon killed if the pest is not removed. Human beings die if, when infested in nose or ear, immediate treatment is not procured. This pest is much worse in the South than elsewhere, but occurs in the North in considerable numbers.

Control.—The eggs are said to be destroyed by sunlight. Prompt attention should be paid to the health of all farm animals, and all sores should be quickly treated. A physician in the case of human beings or a veterinarian in the case of stock should be consulted immediately after infestation. Filth of any sort should not be allowed to accumulate. Wounds should be promptly cleansed and anointed with an antiseptic, such as extremely dilute

carbolic acid. A subsequent coating of pine tar may aid in repelling the flies. Creolin may be more effective than carbolic acid. Applications of this sort should be made by some one more or less conversant with the use of these agents.

The Flesh Fly.—The adults of the well-known blow-flies (*Sarcophaga* sp.) are always on hand to blow meat in the summer time when left exposed. The female gives birth to a large number of maggots, which are hatched within the mother. When first born they are mere specks, but in a few days they grow to be one-half of an inch in length. These maggots are deposited on any exposed meat or in damp, filthy places. They will also deposit maggots in the interior of the ears of stock, and particularly on wounds and sores, which they enlarge and keep from healing. Transformation from maggot to pupa takes place in the ground—the winged adult emerging in a few days, ready to start another generation.

Value and Injury.—To a certain extent these flies are beneficial, since they act as scavengers, but they are a great nuisance to man and animals, because they run over them in search of food. Like other flies, they undoubtedly carry filth and disease germs. As intimated above, they attack fresh meat which has been left exposed, as well as carrion, and are particularly annoying through their persistence.

Control.—All wet and filthy hair on animals should be cut, especially that around wounds and sores, and such wounds or sores should be rendered antiseptic. This can be done by applying carbolic acid, one part to fifty of water, or one ounce of oil of tar to twenty ounces of sweet oil. Maggots found in the wounds of infested stock should be removed.

The Horn Fly.—This fly (*Lyperosia irritans* Linn.) is a little smaller than the house-fly, but more slender. It is about the same color. It is frequently observed clustered at the base of the horns of cattle (Fig. 328). It seeks that location because it is there safe from disturbance.

Injury.—It attacks the back, sides, and flanks of cattle, sucking the blood and causing a falling off in milk supply on account of the annoyance to the animal. These flies are small, but the blood taken by a few thousand is considerable. Dark cattle appear to be more attractive to the horn fly than light-colored animals.

Life History.—Eggs are deposited in the field in freshly dropped dung. They hatch quickly, then enter the ground, and

there pass the pupal stage. There are several generations during the year.

Control.—Tar and fish oil in equal parts may be applied as a repellent upon the flanks of cows; or a mixture of half a cup of kerosene in a quart of rancid lard may be used in the same way. The latter repellent is ordinarily effective for two or three days. When numbers of cows are to be treated, spraying with fish oil should be resorted to. As is well known, cows kept in the stable during the day and turned into pasture at night are exempt from attacks of all insects that fly during the daytime.

The Stable Fly (*Stomoxys calcitrans* Linn.).—This fly also closely resembles the house-fly. Very abundant about stables in the late summer and early autumn, it sometimes enters dwelling houses in muggy weather. Sharp, piercing mouth-parts distinguish it from the house-fly. Its habits are very much the same as those of the latter.

FIG. 328.—Horn flies on horn of cow.

Life History.—The eggs are laid in moist, decaying substances and hatch in from one to three days. The pupal stage lasts from six to twenty days, depending upon temperature. Unlike the house-fly, it does not, by choice, breed in manure, but prefers wet straw stacks or manure containing plenty of straw. It is found to be more abundant in old oat straw than in wheat straw, and breeds in numbers in debris left from threshing. The complete cycle, from egg to adult, occupies about nineteen days.

Injury.—Like other flies which frequent filth, this one is potentially a distributor of disease. It is practically cosmopolitan, but becomes of great importance in the grain belt. It can easily bite through clothes, and frequently bites ankles when low shoes are worn. It is very evident that, since it flies from one animal to another, it may be the cause of spreading anthrax in both animals and man; also glanders; and possibly swamp fever in horses. It also acts as an intermediate host for a round worm of cattle, as well as for many diseases of animals, in other continents. In Texas the loss from the attacks of this fly is estimated at over twenty-five thousand dollars.

Control.—As recommended for the house-fly, stable manure, particularly that in which there is much straw, should be removed as often as possible, at least once a week. Wet straw should not be allowed to accumulate. Working animals should be protected by nets or other covers. Stables darkened, but allowing ventilation, afford protection. Thorough screening of all windows and doors is advisable.

The Blood-sucking Oscinis.—This is a very small, polished black fly (*Oscinis pallipes* Loew.) (Fig. 329) with yellow face and legs. It is hardly more than one-eighth of an inch from tip to tip of its spread wings.

Little is known of the life history. It is very probable that the

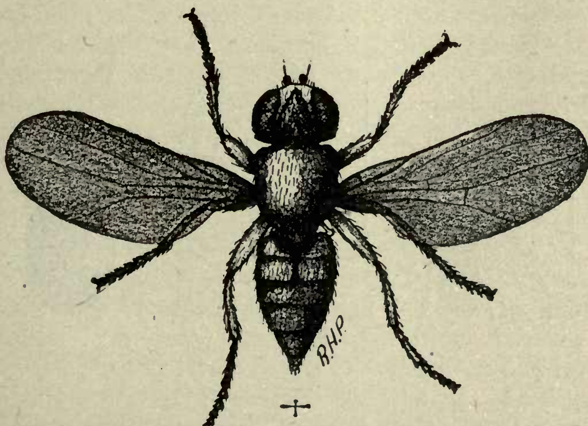


FIG. 329.—The blood-sucking Oscinis. Greatly enlarged. (Lugger.)

larvæ and the life history resemble those of other members of its family, *Oscinidæ*. The others are strictly vegetable feeders in both larva and adult stages. (See, in this connection, *Oscinis soror*, under wheat pests.)

Injury.—During the summer this fly is exceedingly abundant in some localities, attacking horses, cattle, dogs, etc. Its movements are rapid; it is most persistent in its attack and difficult to drive away. It seeks places on animals where protection is afforded by hairs, and its attacks soon cause a great flow of blood. When engorged with food, it drops to the ground and is unable to fly; then other flies, attracted by the flowing blood, add to the animal's previous injury. This soon results in large sores, and animals become frantic as the result of repeated attacks.

The Sheep Bot-Fly, Sheep Gad-Fly, "Grub in the Head," "False Gid."—This bot-fly (*Œstrus ovis* Linn.) is dull yellow in color, looks a little like a large house-fly, and has no mouth. It places its living young in the nostrils of sheep, the egg having been hatched in the body of the parent. The attempts of the female fly to reach this point drive the poor animals frantic. They lie down, bury their noses in the dust, throw dust in the air, huddle together, etc. This fly, like most allied pests, is fond of hot sunshine, and flies on warm and sunny days between May and October (Fig. 330). The young larva, once in the nose, works its way upward, occasionally gaining lodgement in the frontal sinuses—cavities between plates of bone over the eyes. Ten months are

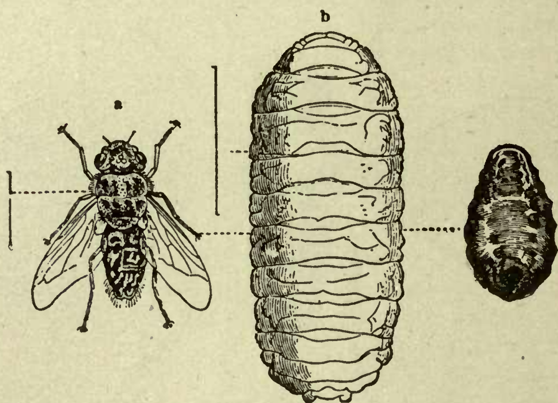


FIG. 330.—Sheep gad-fly: *a*, adult; *b*, larva; on right, puparium. (After Brauer.)

required for the maggots to mature, at which time they crawl back to near the anterior opening of the nose and are sneezed out. They remain in the pupal stage, one or two inches below the surface of the ground, from four to six weeks.

Injury.—The adult flies pester the animals as above described. The upward migration of the larva in an animal's head and its activity cause serious symptoms in the affected animal. These occasionally result disastrously. This, however, according to Neumann, occurs only when the bots are quite numerous in the animal, and are well advanced in their development early in the season. Animals seriously affected lose their appetite, become emaciated, discharge thick mucous matter from the nose, sometimes throw their heads back, or, hanging their heads, lift their

feet high in the air when walking, grate their teeth, and froth at the mouth. This is followed by convulsions and, finally, death within six or eight days after the appearance of the first symptoms.

The above symptoms are sometimes wrongly ascribed to the attacks of worms which cause the sickness known as "gid," or "turn sick." The presence of the bot-fly, however, does not cause the animal to turn in a circle, as in the case of "turn sick." The presence of the bot, too, nearly always causes nasal discharges and snorting, which symptoms are absent in a case of "gid."

Remedies and Means of Prevention.—In the case of common stock destined for the market, a very general and serious attack can perhaps best be met by sending the sheep to the slaughter-house. On the other hand, there are a few remedies or methods of preventing an attack or of relieving the sufferers. If the bots have penetrated into the frontal sinuses, it is apparent that it must be very difficult, if not impossible, to reach them. Certainly one should never use a wire, nor any compound which would injure or cause great suffering to the patient. When the bots are in the nostrils only, they may be removed sometimes by using a feather dipped in turpentine or very weak carbolic acid (one part of acid to thirty parts of water), or creosote or zenoleum. An injection of salt water or diluted carbolic acid into the nostrils with a syringe is claimed to be of use. Fine, air-slaked lime is sometimes used, the animals being forced to breathe it, that sneezing may be induced. Dr. Lugger states in one of his reports that he met with success by blowing pyrethrum up the nostrils. Anything which will induce sneezing is good: tobacco snuff shaken into the nostrils, the burning of horns, leather, or feathers, in a closed shed where the sheep are confined, etc. It is claimed also that equal parts of turpentine and sweet oil poured into the nostrils carefully, the head being held up, is excellent, care being taken that the sheep may not be choked. But, as intimated above, all these remedies would avail little or nothing if the bots were safely housed in the bones of the forehead.

Keeping Away the Flies.—Some sheep-raisers in infested localities maintain, from May to October, in pasture or yard, logs, along which, at intervals of five or six inches, two-inch holes are bored. These holes are kept about half filled with salt, and the edges or the mouths of the holes are frequently smeared with fresh tar. The sheep, in endeavoring to reach the salt, involuntarily smear their noses with the tar, and this tends to keep off the flies.

As an auxiliary to this—for they will not all get a liberal allowance of tar on their noses—one may rub into the nostrils and about the noses the following compound: Pine tar, two parts; fish oil or cottonseed oil, one part; powdered sulfur, one part. Some farmers plow a few furrows across the pasture, into which the sheep may stick their noses when attacked. Some breeders keep deep dust in a portion of the sheep yard, into which the animals instinctively thrust their noses when attacked by the fly. This, however, affords only temporary protection, since the fly returns to the attack as soon as the animals leave the furrow or dust pile.

All modern books on sheep-raising undoubtedly contain the latest and best remedies for all parasites of sheep. One or more good books of this kind should be in the hands of every sheep-raiser.

♀

FIG. 331.—Green-head fly. Much enlarged. (Lugger.)

Tabanids.—These are variously known as horse-flies, breeze-flies, and gad-flies—these two latter terms also being applied to the *Œstridæ*. Some, which are found more particularly in the timber and affect deer and moose, are called deer-flies; some are referred to as "green heads" (Fig. 331).

To fit these flies for their parasitic habit of preying upon quadrupeds, nature has equipped them with powers for extremely rapid flight, and they can easily overtake the fastest deer or horse. It has even been said of them that some can fly faster than an express train at full speed.

Both males and females are found on flowers, the males confining themselves to a diet of nectar, and never biting; the females, only resort to the sweets offered by flowers when blood cannot be obtained. These flies not only infest quadrupeds, but as some of

us know to our cost, many of them do not scruple to attack man. Warm weather and bright sunshine appear to be the conditions most conducive to their activity. They are, as a rule, more numerous in the vicinity of low or marshy places. The adults appear to be especially fond of water, and their brownish or black eggs, in the case of those whose larval life is passed on land, are deposited either on stems or leaves. In the case of aquatic forms, eggs are laid on reeds in the water. Pine woods, too, seem to attract them. Some forms of larvæ are said to live in rotten wood. The larvæ are always carnivorous, feeding on snails or insects in their early stages, thus offering something of a compensation for the mischief caused by them as adults.

Injury.—Not only are the attacks of tabanids exasperating to both man and beast, but it is quite possible, even probable, that they may transmit disease by biting a well animal after having fed upon the blood of some infested creature. They are probably active agents in distributing the disease known as "anthrax." The writer was appealed to for help at one time by a mail carrier in the northern part of Minnesota who had to discontinue carrying mail on account of the attacks of *Tabanidæ* upon his horses.

The larva of one species of *Chrysops* is said to eat plant lice.

Control.—Nets or light covers are, of course, a protection, particularly the latter. Where nets or light coverings cannot be used, anointing the horses with repulsive ointments, such as fish oil or fish oil and tar, will be of benefit. Care should be taken never to use machine oil for this purpose, as the results of its use are disastrous to the hair.

The eggs of *Tabanus atratus* Forst. are parasitized by a tiny, four-winged fly known as *Phanurus tabanivorus* Ashm.

Some members of the genus *Chrysops* appear to direct their attacks to the region about the eyes and ears of stock. Horses' ears may be protected by nets, or the ears and skin about the eyes may be smeared with the following solution: Pine tar, one gallon; kerosene or fish oil or crude carbolic acid, one quart; powdered sulfur, two pounds. This mixture also applied to wounds, as those made by barbed wire, will keep off flies which might otherwise lay their eggs in the open wounds.

Mosquitoes.—Members of this family, *Culicidæ,* when occurring in great numbers, cause annoyance to stock, and frequently excessive loss of blood. E. P. Niles, of Virginia, states that he has seen occasions in northern Iowa when it was necessary to

drive cows into a smudge before they could be milked. The writer has had the sleeves of his coat so covered with mosquitoes in the Red River Valley, Minnesota, that they presented a gray color, the original color of the cloth being hidden. Swampy pasture land will always be a breeding place for this pest.

Control.—Stock can be protected, in a measure, by the following mixture, frequently applied: Melt two quarts of lard and two tablespoonfuls of coal tar, then add one quart of kerosene, one teaspoonful of turpentine, one teaspoonful of oil of pennyroyal. Apply with a rag, sponge, or brush. This is sufficient, of course, to make application upon a few animals only. A number of the strong-smelling compounds recommended in this publication for use against flies on stock will temporarily protect the animals to which they are applied. Man finds relief by applying oil of citronella, for sale at many drug stores, anointing the face, back of neck, and hands. One should avoid getting this too close to the eyes. (See page 307, Insects Affecting Man and the Household.)

The Scab Mite of Sheep.—The scab, caused by the presence and activity of the above-named mite (*Psoroptes communis* Furst, var. *ovis*), is one of the most dreaded diseases among sheep-growers. It is rightly said to be more injurious than any other disease caused by external parasites. In many countries it is so important that stringent laws have been enacted to check it.

Life History.—The scab mite (Fig. 332) is not a true insect, but belongs to the class *Arachnida*, where we find the ticks and mites, spiders and scorpions. In the adult condition it has eight legs, in the young stage six. Its length of life is from three to six weeks. The tiny eggs are deposited on the skin and under the scabs on the skin, when they are formed. They are said to hatch in from four to seven days. Every female lays an enormous number of eggs. Moisture is conducive to their development.

Injury.—The first noticeable symptom of scab in sheep is a scratching, rubbing, and biting by the infested animal, due to the intense itching, particularly when the creature has become warm by being driven or kept in a warm stable. This intolerable itching causes the sheep to rub itself, and the wool, loosed by the scabby condition of the skin, is rubbed off in patches (Fig. 333). The coat of a scabby sheep looks rough, and the wool can be easily pulled out in places. As the scab spreads, the mites are found at the edges and the older points of attacks take on a characteristic incrustated appearance. The incrustated appearance is due to

the exudation and drying of a lymph-like liquid, which gathers in minute sacs or pustules in the skin, as the result of the activities of the mites.

Dipping after shearing, and keeping the animals for at least four weeks away from their old quarters, will tend to prevent reinfestation. Two dippings, with an interval of from six to ten days between treatments, are necessary; in severe cases even three dippings are advised. Various dips are in use. Those containing arsenic are not recommended, on account of their poisonous nature. The dips containing tobacco, and the lime-sulfur-dip, are excellent.

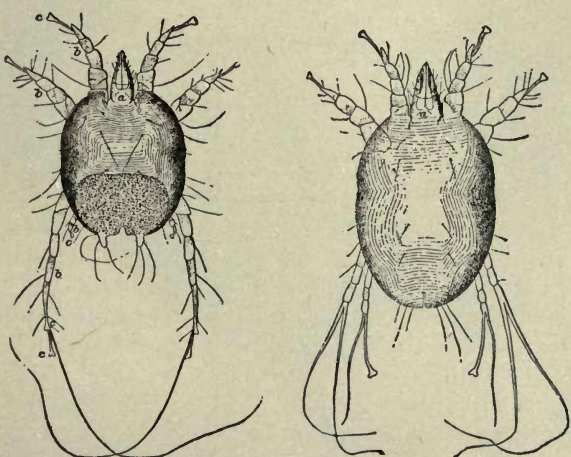


FIG. 332.—Scab-mite of sheep, male on left, female on right. Much enlarged; *a*, head; *b*, *b*, legs; *c*, *c*, suckers. (After Curtice.)

The United States Department of Agriculture has, in the past, recommended the following dip for scab: 20 pounds of lime, 25 pounds of powdered sulfur, 100 gallons of water. Slake the lime, and add the rest of the water and the sulfur; boil twenty minutes and strain. This is said by some to be too severe both on wool and skin. The coal-tar dips, used in accordance with the directions given by the manufacturers, are advised. Each sheep should be held in this solution until the scabs are thoroughly soaked, possibly two minutes for each sheep, immersing the head at least once. Give a second dipping ten days later and possibly a third after an equal interval. The temperature of the dip should be 103 degrees F. Dip suspected sheep, which have been purchased,

twice before adding them to your flock. This will destroy all external parasites. This dip could also be used, in about this strength, on other animals suffering with any external parasite.

Other Control Measures.—Infested stables or pens should be sprayed with the same mixture, or with kerosene emulsion, and the sheep kept away from them for four weeks. Whitewashing the interior of such buildings or pens after spraying is naturally a good measure. The dipping pen is an important furnishing of

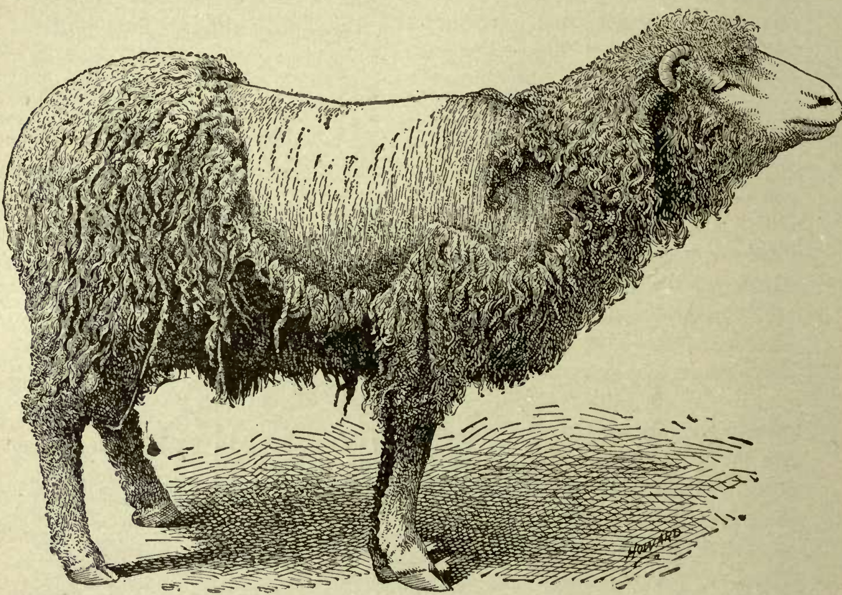


Fig. 333.—Sheep badly infested with scab.

every sheep farm. Scabby sheep should not be driven along a public highway, for evident reasons. Keep sheep out of pastures previously occupied by infested sheep.

The Sheep Tick.—This species (*Melophagus ovinus* Linn.), formerly called *Hippobosca ovinus* Linn., is found the world over, wherever sheep are kept. The sheep tick (Fig. 334) is about one-sixth of an inch long, a wingless and degenerate fly, and is apt to be common where sheep are kept in crowded quarters. It is only when sheep are crowded together that this parasite crawls from one animal to another. The adult female brings forth young in

the larval stage, and the species is most abundant in spring and summer. Lambs suffer particularly just after the older sheep have been sheared, for in the hair of the unsheared lambs the ticks find a safe retreat and succulent food close at hand. It is roughly estimated that a tick will take from a lamb four drops of blood per day, or possibly about one-fifteenth of a fluidounce. As many as one hundred ticks can be found sometimes upon one lamb. If we, however, halve that number, averaging it at fifty ticks, a conservative estimate, we get the astonishing result of two hundred drops of blood being sucked from the lambs daily.

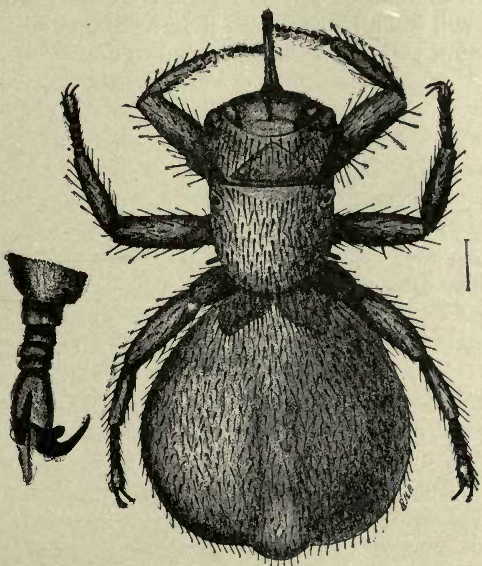


Fig. 334.—Sheep tick, enlarged, and enlarged foot. (Lugger.)

Treatment.—Scrubbing or combing or washing with water will do but little good. Dipping with some insecticide is the only sure remedy. Dips are made from coal-tar or creosote products as follows: One gallon of dip to one hundred gallons of water; this to be used once in the spring immediately after shearing, and again in the fall before the sheep go into winter quarters. They should be kept in the liquid at least one minute. If they are not so dipped, the ticks, as mentioned above, will migrate as soon as possible to the unshorn lambs.

Sheep added to the flock from the outside should be dipped before they join the home flock, to prevent the introduction of ticks and other parasites. Dipped sheep should not be returned at once to the same pen or enclosure occupied before shearing or dipping, but should be allowed to remain for a while in a different enclosure to prevent reinfestation. A second dipping should be given about twelve days after the first. However, a careful

examination of a few sheep will determine whether there are enough ticks on them to call for this.

Wool, if infested when clipped, should be stored at a distance from the sheep in order to be sure that no ticks escape from it, to return to the animals.

Dipping for ticks will at the same time kill lice and many other external parasites.

A thorough spraying of the pens or other enclosures, with zenoleum of the strength given above, or with kerosene emulsion, will kill all wandering ticks or mange mites and most other vermin, and this is a desirable thing to do.

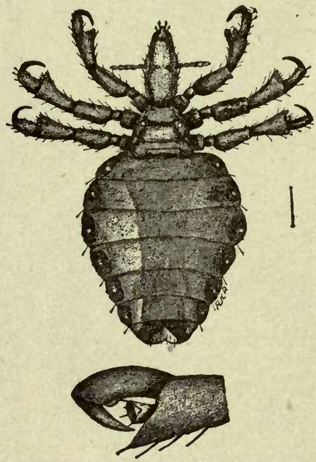


FIG. 335.—Hog louse and enlarged foot. Hair line shows actual size. (Lugger.)

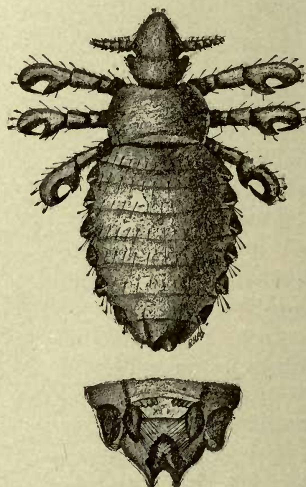


FIG. 336.—Short-nosed cattle louse. Tip of abdomen from below. (Lugger.)

Lice.—Zenoleum has been found to be one of the best insecticides to use for lice on hogs, horses, cattle, etc. On hogs (Fig. 335), use one part of zenoleum to thirty parts of water, applying either by spraying or with a stiff brush or sponge. Some hog-raisers construct a dipping pen in connection with the hog-house and there the hogs are dipped. The dipping should be repeated in from ten days to two weeks after the first treatment.

For lice on horses and cattle (Fig. 336), zenoleum is used at the strength of twelve tablespoonfuls to every gallon of water, applied with a stiff brush or spray pump or sponge. Every part of the body should be washed thoroughly and the application repeated in eight

or ten days. Crude oil warmed to about blood heat and rubbed along the back, between the legs, and around the tail, neck and head, is also advised. Stables should be whitewashed. Animals may be clipped and then washed with sheep dip.

Black Flies, or Buffalo Gnats.—These minute flies, belonging to the family *Simulidæ,* are always more or less troublesome to stock in certain localities, and when found in great numbers cause much loss. In 1884, in Franklin Parish, Louisiana, they killed three hundred head of stock in a week. Horses, mules, cattle, sheep, hogs, and poultry are sufferers. Only the females bite, but many of us can bear witness that each female can do enough mischief for two. They are attracted to stock from long distances.

Control.—Animals which have not shed their winter coats suffer more than those whose skin is smooth, since the flies can apparently get a better hold where long hair is present. Horses clipped in the early spring, therefore, would not suffer as much as the unclipped animals. Horses and cattle in darkened stables are not attacked. Where a preventive is called for, use fish oil, or fish oil with a little kerosene added. Mix one part of kerosene to three parts of fish oil. Apply twice a day or oftener. This would be of benefit to a working team. (See page 310 for further discussion, and see figure 318.)

The Green-bottle Fly.—Flies of this species (*Lucilia cornicina* Fab.) lay eggs on dung in pastures. Occasionally they lay their eggs in the dung which sometimes sticks to the rumps of lambs when loosening food has been eaten, if the tails have not been docked.

The maggots from these eggs work in the dung and attack the tender skin and flesh, causing festering sores, and frequently the death of a lamb.

Anything which will keep those parts clean is the manifest treatment. Practice early docking. Care as regards diet is especially necessary.

The Blow-Fly or Meat-Fly is a large, blackish fly with bluish abdomen. It belongs to the species *Calliphora vomitoria* Linn. When cabbage or cauliflower and corned beef are being cooked these flies in large numbers come about the kitchen door, or inside if the door is not screened. They lay their eggs, which quickly hatch, upon meat and vegetables, and are at times a great nuisance. Packard says that in the Civil War wounded soldiers lying on the field were tormented by these flies endeavoring to lay eggs in their wounds.

Treatment of Wounds.—Wounds on stock should be quickly dressed with weak carbolic acid. Use one part of carbolic acid to thirty parts of water. Then coat them with tar (U. S. Department of Agriculture). If eggs are already in the wounds, they should be removed carefully, the wounds washed with the above carbolic acid solution, and dressed with tar.

Mange.—This disease is caused upon various animals, horse, cow, sheep, wolf, hog, dog, and other animals, by different varieties of minute mites, not insects. A common species is known as *Scaroptes scabiei* Latr. This mite (Fig. 337) occurs on man to a certain extent. It is commonly called the "itch mite," and its burrowing in the skin causes intense irritation and loss of hair

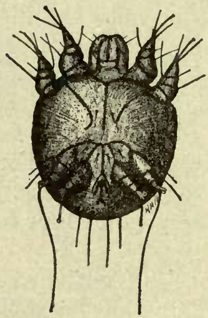


Fig. 337.—Itch-mite of man, male, greatly enlarged. (Lugger.)

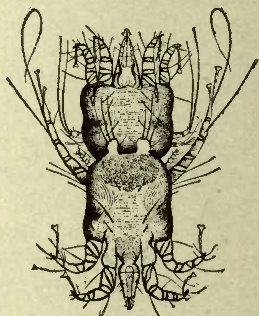


Fig. 338.—Mange-mites of the horse, male and female, much enlarged. (After Meguin.)

on the affected parts. Figure 338 is a mite which causes mange on the horse. Figure 339 is a similar pest working on the dog. Figure 340 is a mite causing foot mange on the horse.

Control.—It can be controlled by the various dips and washes used against scab, ticks, and lice. Anointing the affected parts with lard and sulfur has given good results. Hot water and zenoleum may be mixed at the rate of fifty parts of water to one part of zenoleum. Allow it to cool before using. The cost of spraying cattle with this is about three or four cents per head. A mixture of zenoleum and lard is also recommended. Adding powdered sulfur to the zenoleum and lard will increase the efficacy of the mixture.

Chicken Scab.—This is often called scaly legs in fowls. It is caused by one or more species of mites which attack the combs

and legs of our common fowls. These parts become scaly on the surface (Fig. 341). The scales can be rubbed off, disclosing an unnatural brownish color when on the comb, entirely unlike the healthful red color we would expect to see. Figure 342 shows fairly well the appearance of the legs of poultry suffering from the attacks of this parasite. The legs look whitish, and the fowls, irritated no doubt by the itching, pick at them. One infested fowl obviously can easily spread the trouble to other fowls which occupy the same yard or roost.

Control.—Naturally the various dips which are used to kill other mites and lice would be efficacious here. One mixture recommended is four tablespoonfuls of zenoleum in one gallon of

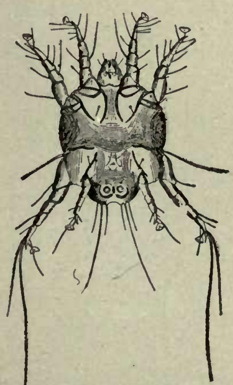


FIG. 339.—Itch-mite of the dog, male. Much enlarged. (After Neuman.)

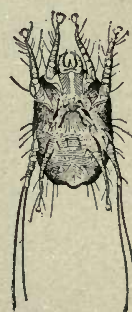


FIG. 340.—Mite causing foot-mange in horse. Greatly enlarged. (After Neuman.)

water. Hold the legs in this two or three minutes. Do not scrape the scabs when dry. Afterward rub the legs with some sweet oil or lard a few times. A five per cent solution of creolin is also claimed to be effective in such cases.

The Poultry Mite.—This grayish mite, which becomes red after a meal of blood, is familiar to almost all who keep poultry. This mite and the biting lice found on fowls are often grouped under the head of "lice." Mites are not true insects, as they have eight legs in the adult stage. The mites thrive best in damp, uncared-for poultry houses.

Control.—Cleanliness, sunlight, and fresh air are among the best preventive measures. Roosts should be removable, since

the mites congregate under the ends of the roosts, and in cracks and crevices near the roosts. Feeding is done entirely at night, and one infested bird may be the cause of the pest spreading through the entire poultry yard. The inside of the house should be regularly sprayed with crude petroleum, kerosene emulsion, pure kerosene, or some tobacco extract. Since the eggs laid in crevices and cracks may not be reached by the spray, a second spraying should be given a week after the first, in order to catch

FIG. 341.—Chicken scab on head of fowl. (Lugger.)

the young lice that hatch from the same. Hundreds of these mites (Fig. 343), congregated on the under side of roosts may be burned in the daytime by passing the flame from a lighted paper rapidly from one end of the roost to the other. Or brush the roosts with a liberal application of crude oil. Occasional whitewashing of the interior of the house is another help.

Feather Lice of Fowls.—There are a number of "biting-lice"—not true lice, which belong to an order of insects known as *Mallophaga*. Different forms of these occur not only on chickens,

turkeys, ducks, geese, pigeons, and other feathered animals, but also on the dog, cat, sheep, cow, horse, etc. Among them are the four species: *Menopon pallidum*, *Goniocotes hologaster* by Nitzsch; and *G. burnettii* Packard; and *Lipeurus variabilis*. Some of these

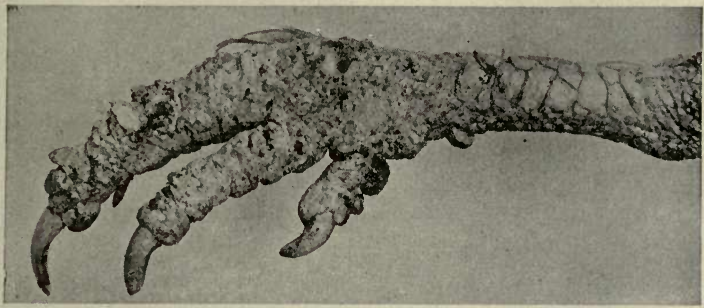


Fig. 342.—Chicken scab on foot of fowl. (Lugger.)

(Fig. 344) are found on our domestic poultry and are very much in evidence when one is "dry-picking" a chicken or turkey.

These insects are flat, yellowish or pale colored, and somewhat broad in proportion to their length. They are approximately about one-tenth or one-twelfth of an inch long, and are easily seen with the naked eye.

Fig. 343.—Chicken mite. (After Lugger.)

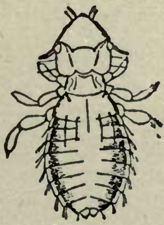


Fig. 344.—Feather louse or biting louse of chicken. (After Packard.)

Control.—Provide a generous dust bath for fowls at all times. Keep the hen-house clean; whitewash liberally. Spray with crude petroleum in feathers of adult fowls. Do not build the hen-house against the barn, lest these pests annoy other stock.

The Cattle Tick and Spotted Fever Tick.—Not only are a number of insects guilty of transmitting disease either directly

or indirectly, but among the *Arachnids* at least two ticks, in the light of our present knowledge, are now recognized as dangerous. These both inflict loss upon cattle raisers.

"Texas fever" or "Tick fever" affects southern cattle infested with the species of tick *Margaropus annulatus* Say. Its ravages are not confined to Texas. The disease is infectious, caused by the transmission into the blood of the animal of a parasitic protozoan existing in the body of the tick. Symptoms of the presence of the disease are high fever, a reddish urine, loss of flesh, and, in a large number of cases, the death of infected cattle. This disease may also occur in northern cattle, brought south and turned out upon the ranges; or northern cattle may become infected from ticks brought north on southern cattle. Specimens of this tick (Fig.

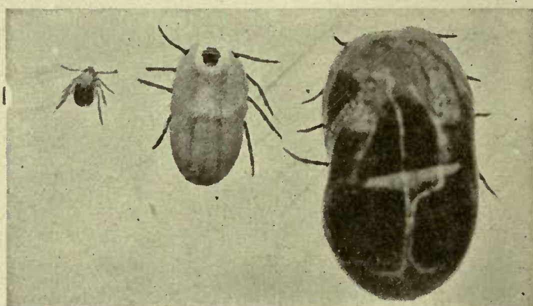


FIG. 345.—North American fever tick; newly moulted nymph on left, adult female just beginning engorgement, and fully engorged female. (After Cotton, Tenn. Bull. 113.)

345) have been found on dogs frequenting the tick-infected country. The pest has so seriously threatened the cattle industry that the Federal Government has established a quarantine line, imposing severe restrictions on the passage of cattle out of the quarantine zone. In states south of this line the fever tick has cost agricultural interests every year something like one hundred million dollars (Tenn. Bull. 81).

The Rocky Mountain spotted fever tick (*Dermacentor venustis* Banks), transmitter of the disease known as Rocky Mountain spotted fever, has been most destructive in the Bitter Root Valley, Montana, but also occurs in Nevada, Idaho, Utah, Wyoming, and possibly other states. When human beings are bitten by this tick eighty per cent of the cases result fatally.

Life History.—Immature ticks of this latter species frequently feed on smaller mammals, such as ground squirrels; the mature

forms on cattle. The life history of each, as well as that of many others of this group, is, generally speaking, the same, differing in minor details. One difference of detail is that the fever tick moults on its original host, while other native species, the dog tick for

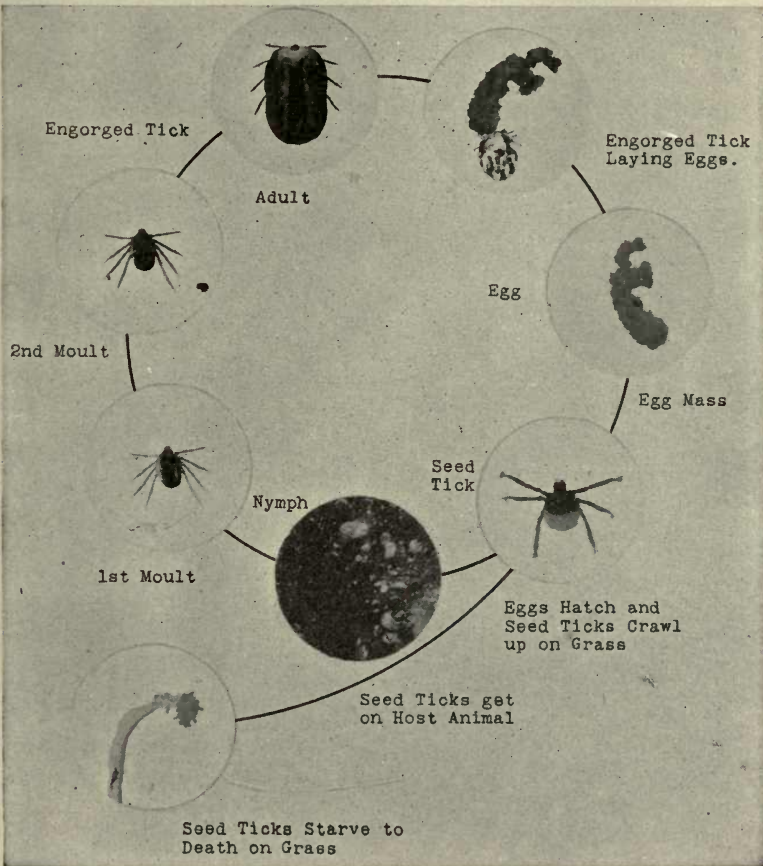


FIG. 346.—Life cycle of North American fever tick. (After Cotton, Tenn. Bull. 81.)

example, drop to the ground to moult and then seek other hosts. The engorged and fertilized adult female lays on the ground about 1500 or 2000 or more eggs. It may take from three weeks to seven months or more for these eggs to hatch. The young tick called "seed tick" crawls to the top of weeds or grasses, to await there a

host to which it may attach itself. After this is accomplished it undergoes several moults, and finally drops to the ground, the fertilized females engorged with blood. These lay enormous

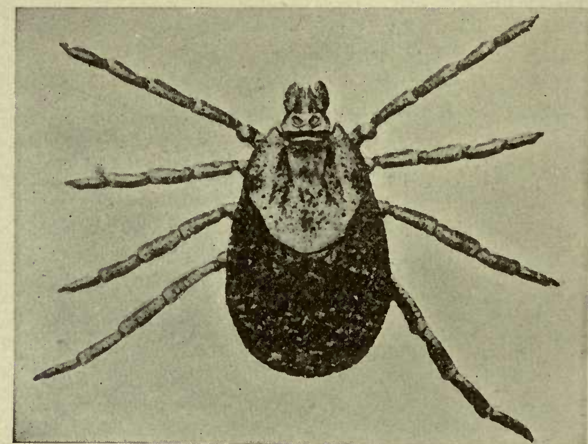


FIG. 347.—Rocky Mountain spotted fever tick. Much enlarged. (After Cooley, Mont. Bull.)

numbers of eggs, as above stated. The disease may be transmitted through the eggs to the next generation of ticks. The life cycle of the North American fever tick is illustrated in figure 346.

Control of Texas Fever Tick. — If cattle are kept out of the pastures they naturally escape attack, and most of the young ticks will starve for lack of food. A four- or five-year pasture rotation is also advised in the following order: Corn, spring oats, hay meadow, pasture (Tenn. Bull. No. 81). It is claimed that this will rid a farm of ticks. Application of oil to newly infested stock is also practiced, the material being applied with spray pump,

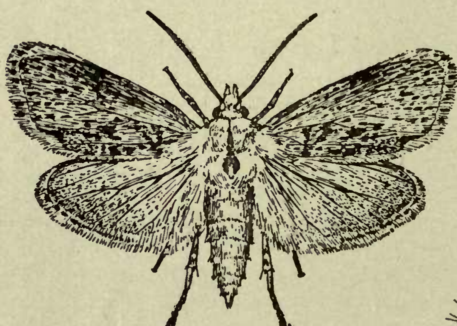


FIG. 348.—The bee moth.

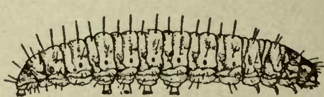


FIG. 349.—Larva of bee moth.

brush, or mop. Emulsion used in the process is made by dissolving one-half pound of soap in one-half gallon of water by boiling. After taking from the fire, add two gallons of Texas black oil and churn until a creamy emulsion is formed. When wanted for use, five gallons of water (preferably soft water) is added to the above amount of stock solution.

Control of Rocky Mountain Spotted Fever Tick (Fig. 347).—As with the previous pest, immunity is obtained by keeping domestic animals free from ticks. This desirable end is obtained

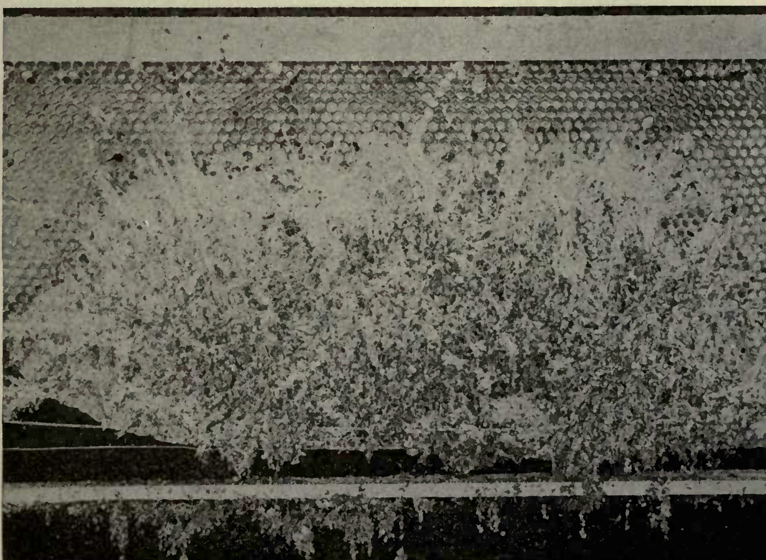


Fig. 350.—Frame of comb, badly injured by bee moth. (Original.)

in much the same way as recommended above, especially by spraying or dipping animals at the first appearance of the ticks. The destruction of ground squirrels and other rodents which may and do harbor young ticks in a tick-infested locality is of questionable value, but it has been practiced by some cattle men.

The Bee Moth (*Galleria mellonella* Linn.).—This grayish moth (Fig. 348), whose larvæ (Fig. 349) work in comb and honey, is rarely injurious to a strong colony of bees, which is, if properly housed, perfectly able to protect itself. It is only when the number of occupants in a hive has dwindled and the colony has thus

become unable to defend itself, or when an old or badly constructed hive is used, that the moths are enabled to creep into a hive and lay their eggs.

When once established the comb is soon ruined by the activities of the caterpillars (Fig. 350), which later on spin tough silken cocoons throughout the hive. In severe attacks the dwindling colony may desert the hive, leaving behind a foul mass of partially eaten comb interlaced with webbing, defiled honey, and hundreds of the destructive parasites in different stages. Methods of preventing this injury may be inferred from the above statements.

QUESTIONS

1. Describe and give life history of horse bot-fly. State remedies and means of preventing its attack.
2. Do the same with the ox bot-fly or warble fly. State latest views.
3. Are there any insects mentioned in this chapter which are directly injurious to man?
4. Give habits and life history of the flesh-fly.
5. What effects have horn-flies on cattle? Describe their habits.
6. Give habits and life history of sheep bot-fly and remedial measures.
7. Discuss the family *Tabanidæ*.
8. What causes the scab of sheep? Discuss at length.
9. Give life history and remedies for the sheep tick.
10. What remedial measures are suggested for lice on stock?
11. What causes mange?
12. Enumerate the pests of poultry. Discuss treatment of fowls and poultry houses to lessen their attacks.
13. Give life history of the two cattle ticks in North America, and remedial measures.
14. Discuss the bee moth.

CHAPTER XVIII

MILL AND ELEVATOR INSECTS AND MILL FUMIGATION

INSECTS infesting stored grains and their products are often found in mills, elevators, grocery and feed stores, and in homes. The control measures for many of these are somewhat similar. Such treatment is given at some length in the last half of the chapter.

Mediterranean Flour Moth.—This grayish, slender moth (*Ephestia kuehniella* Zell.) is about three-fifths of an inch long. The female has the characteristic habit, upon emerging from the pupal stage, of remaining for hours with the tip of abdomen and head raised above the level of the body. Approximately 200 eggs are laid by each female after mating. They are placed anywhere, in cracks, directly in the flour, in spouts, purifiers, or other machinery, or in sacks containing flour or meal. They hatch in from nine to ten days, and the larval life averages forty days. When full grown the larva spins a cocoon about one-half inch long and transforms to a pupa within. Normally there are probably two broods, though there may be more in warm mills. The female moth may also lay eggs in stored products.

The larva is from white to pink in color, with a reddish-brown head. A few small hairs are found over the body. When full grown it is three-fifths of an inch long and becomes pink in color, which color, however, varies, some specimens being greenish. There are three dark spots on the side of each segment (Fig. 351.)

Injury.—Wherever this larva crawls, it secretes a silken thread which results in a network, causing the formation of great masses of matted flour or meal through which the thread runs (Fig. 352). These masses may clog spouts or any other machinery throughout the mill, rendering the products unfit for use and sometimes even stopping the machinery. Various sources are responsible for the existence of this pest in flour mills. The more common source of infection is found in returned sacks. Second-hand machinery may be a cause.

Control Measures.—The old adage, "An ounce of prevention is worth a pound of cure," is very applicable here. No sacks,

barrels, or second-hand machinery should be allowed to enter the mill without treatment. Scrupulous cleanliness in the building is a strong factor. In large mills, help should be employed and assigned entirely to sweeping and cleaning. A fumigation house might well be constructed where sacks, barrels, etc., could be fumigated. For treatment in badly infested mills, both in case of this pest and other mill insects, see page 353.

Granary Weevil.—This is a small, brown beetle (*Calandra granaria* Linn.), about one-sixth of an inch in length, with a long snout. The grub or larva is shorter than the adult, white in color; robust in appearance; it is found inside of the kernel of grain.

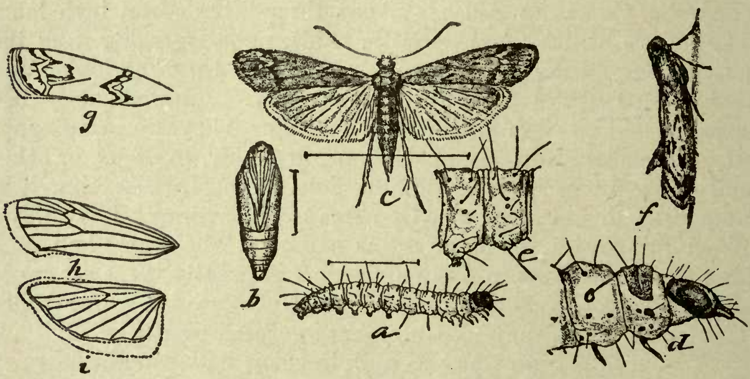


Fig. 351.—Mediterranean flour moth; *a*, larva; *b*, pupa; *c*, adult, enlarged; *d*, head and thoracic joints of larva, much enlarged; *e*, abdominal joint of same, much enlarged; *f*, moth from side, resting; *g*, front wing; *h* and *i*, venation of front and hind wings respectively. (*a*, *b*, *c*, and *e*, Riley and Howard in Insect Life; *d*, *f*, *g*, *h*, and *i*, after Snellen.)

The female beetle punctures a kernel with her snout and lays therein a single egg, the larva devouring the inside of the kernel and changing within to a pupa. The adult emerges six weeks from the time the egg is laid. There may be three or four broods of this insect in the North. In corn, several larvæ may be found in one kernel. Inasmuch as the beetles also eat the grain and are long-lived, they may cause serious damage under favorable conditions. Figure 353 illustrates this species; and also the rice weevil.

Control Measures.—Constant cleanliness is advised, and the prompt removal of dust, rubbish, refuse and sweepings of grain. Granaries should be tight and, as far as possible, without heat, preferably at some distance from other buildings.

Carbon bisulfid is the commonly accepted agent for use with all granary insects. This may be applied directly to the infested grain, or, better, poured through a gas-pipe with the lower end plugged and the sides at lower end perforated, the gas-pipe being pushed down into the grain at different depths. The gas from this liquid, being heavier than air, causes it to descend through the mass. The effectiveness of this treatment varies with the temperature. A temperature below 60 degrees F. renders treatment with carbon bisulfid undesirable. Five pounds for each 1000 cubic feet at 70 degrees or above is advised. The gas formed is explosive; hence, no exposed flame or spark of any kind should be brought near it. The burning of sulfur is hardly effective. For more particular directions regarding the use of carbon bisulfid in elevators and mills, see page 61.

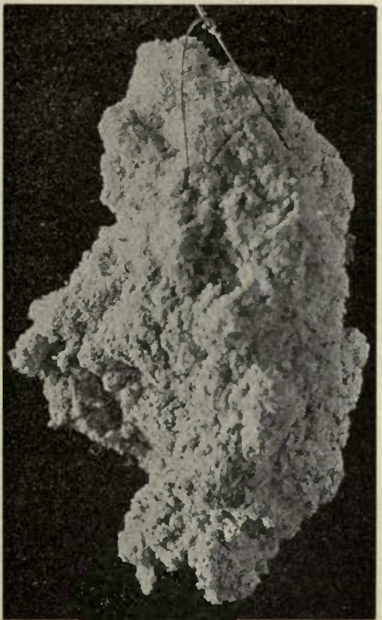


Fig. 352. — Flour matted together by web spun by larvæ of flour moth. (Lugger.)

Heating. — Where possible, heating a mill to a temperature of 123 degrees F., and holding it at that temperature for several hours, has been known to kill all insects in all stages found therein. This has been called the heat method, and, to be successful, it calls for a special plan of arranging the hot-water or steam pipes.

The Rice Weevil (*Calandra oryza* Linn.).—This resembles somewhat the granary weevil and has very similar habits. Their life histories are nearly identical, although the rice weevil may be found in fields remote from the granary. This beetle feeds on rice, wheat, barley, rye, hulled oats, and buckwheat, and frequently invades cracker boxes, cases of breadstuffs, bags of flour, and barrels of meal (Fig. 353).

For measures of control, see granary weevil and also page 217.

The Angoumois Grain Moth.—This pest is named from a

province in France where it has been known since 1736. The moth (*Sitotroga cerealella* Oliv.) is claimed to have been found in America since 1728. It is more injurious in the South than in

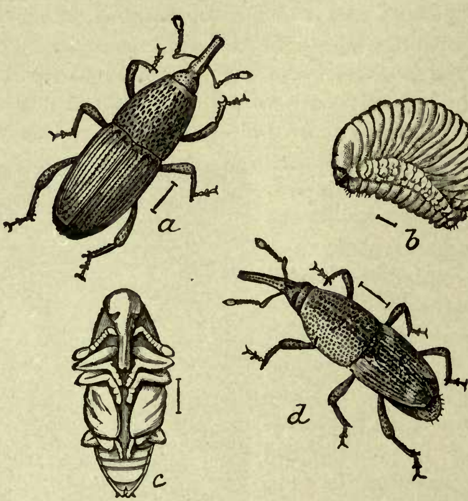


FIG. 353.—*a*, *b*, *c*, different stages of the granary weevil; *d*, rice weevil. The hair lines indicate the size of the insects. (After Chittenden, U. S. Bu. Ent.)

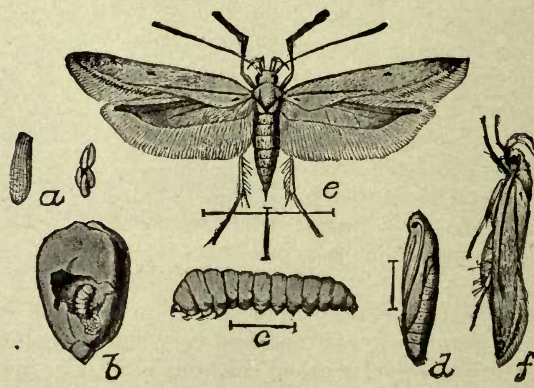


FIG. 354.—The angoumois grain moth; *a*, eggs; *b*, larva at work; *c*, larva, side-view; *d*, pupa; *e* and *f*, moth. (After Chittenden, U. S. Bu. Ent.)

the North. It attacks not only stored grain, but is also partial to many of the breakfast cereals. The moth is brownish in color and resembles a clothes moth in both size and appearance (Fig. 354). (See also page 208.)

Indian Meal Moth.—This is a grayish moth (*Plodia interpunctella* Hbn.) the caterpillar of which fastens together seeds and kernels of grain or particles of other food matter by silken threads. These larvæ (Fig. 355) pass from grain to grain, eating out the germ, injuring the kernels, both for seed and food. An average of five weeks is required for these insects to pass through the several stages from egg to adult. There may be six or more generations in a well-heated mill or store-room. Probably there are four or five broods normally. For remedial measures, see flour moth and fumigation of mills, pages 345 and 353.

Meal Snout Moth (*Pyralis farinalis* Linn.).—This is a light-brown moth with reddish reflections. There are wavy, whitish lines running across the wings. The caterpillar is one-half inch

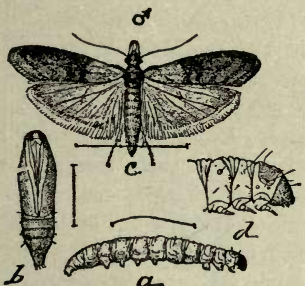


Fig. 355.—The Indian meal moth; *a*, larva; *b*, pupa; *c*, adult male, enlarged; *d*, head and thoracic joints of larva. (After Riley and Howard in Insect Life.)

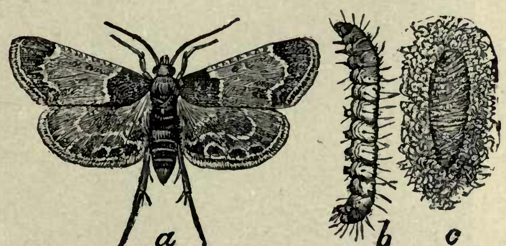


Fig. 356.—The meal snout moth; *a*, adult moth; *b*, larva; *c*, pupa in cocoon, twice natural size. (After Chittenden, U. S. Bu. Ent.)

long when full grown, and resembles in its habits the Indian meal moth. It constructs long tubes of silk from particles of meal or other foods in which it lives. There are about four broods a year, and eight weeks is required to pass through all stages (Figs. 356 and 357).

Control.—If food materials are kept in a clean, dry place, there is but little likelihood of injury. Almost without exception, cases of damage have occurred in cellars, upon floors, in sheds, or in places where refuse vegetable matter is accumulated. For remedial measures, see Mediterranean flour moth and fumigation of mills, pages 345 and 353.

The Confused Flour-Beetle.—This quickly-moving beetle (*Tribolium confusum* Duv.) is scarcely one-sixth of an inch long; it is flattened, and brownish in color. It is very insidious, in that it

creeps into cracks filled with flour or other inaccessible places, escaping the fumes of gas which are successfully used against other mill pests. In a high temperature it is capable of undergoing its entire life cycle in a little over a month. There are probably four broods a year in well-heated buildings (Fig. 358).

Injury.—It is practically omnivorous. Besides grain and its products, it attacks snuff, baking powder, rice, ginger, slippery elm, red pepper, beans, peas, nuts, and seeds of various kinds. It also becomes a serious museum pest by invading cabinets of dried insects. It is a most important flour pest.

Control.—Fumigation with hydrocyanic acid gas is practically the only effective remedy, and that is not always successful, for reasons given above. (See page 353 for fumigation methods.)

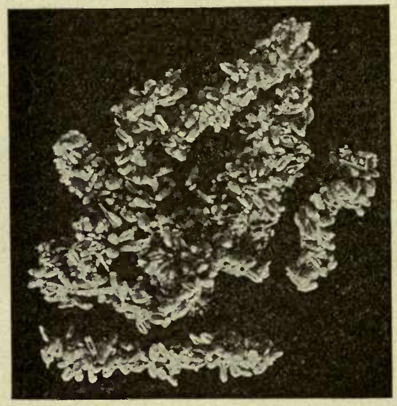


Fig. 357.—Silken tubes covered with wheat made by larvæ of the meal snout moth; half natural size. (Lugger.)

The Yellow Meal Worm.—This beetle (*Tenebrio molitor* Linn.), nearly black in color, is flattened, shining, and over one-half of an inch long. It resembles on a large scale one of the flour beetles. The larva is cylindrical, about one inch long, with a waxy appearance, somewhat like a wire worm. It is yellowish in color. The posterior extremity terminates in two small spines (Fig. 359). The beetle deposits her eggs in meal or in other substances, and the grubs, after hatching, eat the substance in which they find themselves. Two weeks are required for eggs to hatch, and three months pass before the larva or grub becomes full grown. One brood a year occurs. These beetles are fair flyers and are nocturnal in their habits; they are often attracted to lights.

The flour, meal, and other stored products containing these larvæ become foul and unfit for use. For remedial measures, see flour moth and fumigation of mills, pages 345 and 353.

The Saw-toothed Grain Beetle.—This is one of our smallest grain beetles (*Silvanus surinámensis* Linn.), being only one-tenth of an inch in length. It is flattened in form and brown in color. Six small points on each side of the thorax, like minute teeth,

give the name to the species (Fig. 360). The larva is a slender white worm with dark markings. There are from four to six or

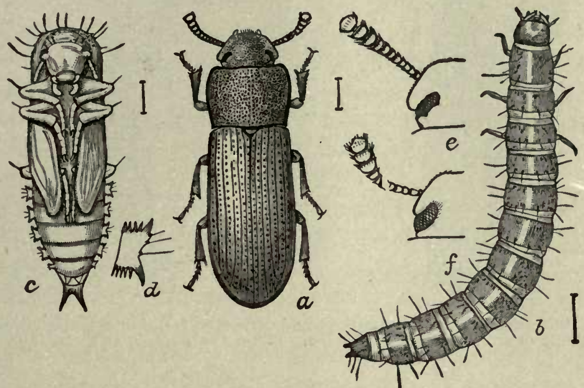


FIG. 358.—The confused flour beetle; *a*, beetle; *b*, larva; *c*, pupa; all enlarged; *d*, lateral lobe of abdomen of pupa; *e*, head of beetle showing antennæ; *f*, same of a closely allied form. (After Chittenden, U. S. Bu. Ent.)

FIG. 359.—The yellow meal worm; *a*, larva; *b*, pupa; *c*, female beetle; *d*, egg with surrounding case; *e*, antenna; all much enlarged. (After Chittenden, U. S. Bu. Ent.)

more generations in a year; the entire life cycle occupies about twenty-four days in midsummer. The pupal stage is passed in the grain, several kernels being fastened together to form a pupal

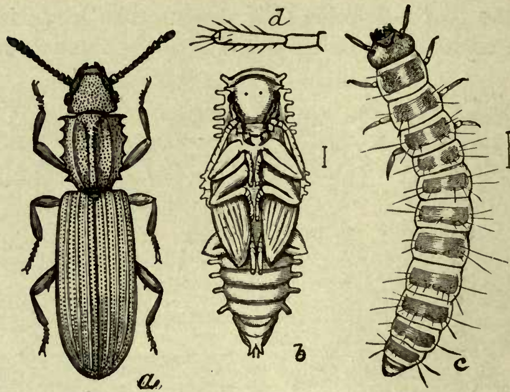


FIG. 360.—The saw-toothed grain beetle; *a*, adult beetle; *b*, pupa; *c*, larva; all enlarged; *d*, antenna of larva still more enlarged. (After Chittenden, U. S. Bu. Ent.)

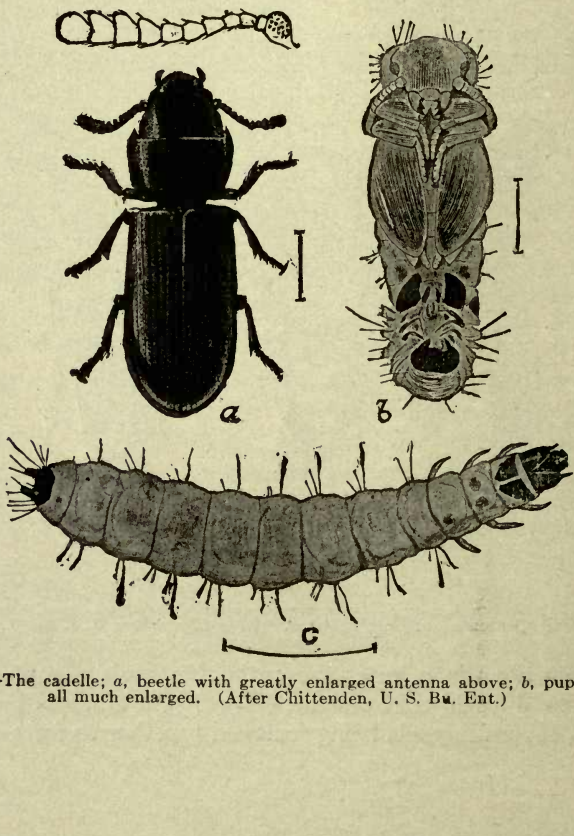


FIG. 361.—The cadelle; *a*, beetle with greatly enlarged antenna above; *b*, pupa; *c*, larva; all much enlarged. (After Chittenden, U. S. Bu. Ent.)

chamber. Sometimes pupation occurs in cracks or crevices in the bin.

Injury.—This beetle, however, does not confine itself to grain bins. It may be found in store-rooms, granaries, pantries, and bakeries. It seems to be practically omnivorous, and its small size enables it to penetrate the smallest cracks. It is cosmopolitan in its distribution. An important fact to be noted is that the larvæ may and do perforate paper bags and cardboard boxes which are used as containers.

The pest is easily killed by carbon bisulfid.

The Cadelle or Bolting-Cloth Beetle.—This interesting beetle (*Tenebroides mauritanicus* Linn.) is fully one-third of an inch long, nearly black, with depressed body. The larva, when full grown, is three-fourths of an inch long and of a dull whitish color with a dark brown head. The three thoracic segments are also marked with brown. The last segment terminates in two horny points (Fig. 361).

Injury.—Though partly predaceous, feeding on other mill insects, this may be a serious pest in a flour mill. Both the larva and the adult cut sacks, and the beetle is said to make holes in bolting cloth. It may be found in accumulations in the bottom of elevator boots and flour conveyors. It is a common pest, frequently found in bags of flour in warehouses. While in search for food, both larvæ and adult devour any grain insects they come across.

Control.—For remedial measures, see measures of control given for other mill insects.

FUMIGATION WITH HYDROCYANIC ACID GAS FOR FLOUR MOTH AND OTHER MILL INSECTS

No process is absolutely perfect, and millers should not, particularly in the case of badly infested mills, expect immunity after the first treatment. The inexpensiveness of the process, and the fact that the gas at the strength used is non-explosive, and the further fact that it in no way injures dry mill products, makes it by far the most effective remedy available. Its poisonous qualities, of themselves, make it safe only in the hands of those acquainted with it, for the knowledge of the possibly fatal results from careless manipulation insures extreme care in its use. Under such conditions, it is to be regarded as a safe agent. But it should be borne in mind not only that the cyanide of itself is poisonous,

but also that one good "whiff" of the gas generated by the contact of acid and cyanide might produce fatal results. Drinking water should not be exposed to the fumes. Bright steel, if not covered, may be slightly tarnished by fumigation.

Advantages of the Treatment.—Summing up the advantages of the hydrocyanic acid gas treatment, it may be said:

1. It is always available and not expensive.
2. It is a method of relief for mills outside of the "freezing" zone, and freezing is by no means an absolute cure.
3. Its use at the strength indicated is absolutely safe as regards fire or explosiveness.
4. It is absolute death, at strength used, to eggs, as well as the other stages in the life of the flour moth.
5. Its deadly qualities of themselves call for such extreme care in its use as to insure safety. In other words, in the hands of those acquainted with its nature and its use, it is a safe agent.

The Method Briefly Described.—Certain conditions are necessary to insure successful fumigation. In the first place, the environment of the building to be treated is of importance. Manifestly, if it is one of a block of buildings, or if there is another building owned by a different party directly contiguous, into which the gas might penetrate where it is not desired, the permission of the owners of such property should be obtained, and precautions taken to prevent accident. When a mill stands by itself at a distance from other buildings with which it is in no way connected, no such preliminary precautions are necessary.

Secondly, the building to be fumigated must be fairly tight. If windows are very loose, paper should be pasted over the cracks. Further, when possible, if the stories to be fumigated are not separated from each other, some temporary inclosure should be made, thus insuring each story getting the maximum amount of gas.

Find *accurately* the number of cubic feet in each story to be treated, making no allowance for machinery or empty bins. Allow 0.25 of a gram of cyanide for every cubic foot of space. After multiplying the number of cubic feet by 0.25, divide by 28.35 to reduce to ounces, and divide this result by 16; the final quotient is the number of pounds (avoirdupois) of cyanide needed. But experience has taught the writer that it is well to use two or three jars more on each floor than the above specifications call for, to insure thorough work; hence it is wise to add nine or ten pounds more for each story, when making up your order. The amount

of cyanide required having been determined, order it from a reliable dealer, *insisting upon* 98 *or* 99 *per cent grade of fused cyanide of potash.* Avoid the use of a low grade.

A half more sulfuric acid than cyanide will be needed. For instance, if a building required 500 pounds of cyanide, 750 pounds avoirdupois of sulfuric acid are needed. This acid must be the *best grade of commercial acid* with a specific gravity of 1.83 or over. Anything below that should be rejected.

The water should always be placed in the jar first (see page 62 for specific directions) and the acid added. Each jar will contain six and three-quarter pounds of water (about three and one-half quarts) and four and one-half pounds avoirdupois of acid. If it is impossible to secure cyanide of potash, cyanide of sodium may be employed, using one-half more acid; for example, three pounds of cyanide of potash call for four and one-half pounds of acid, while three pounds of cyanide of soda would require six and three-fourths pounds of acid. Further, three pounds of cyanide of soda will give off more gas than an equal amount of cyanide of potash. Or, in order to give economy of material due consideration, only four-fifths as much cyanide of sodium is necessary as cyanide of potash. When three pounds of cyanide of potash are called for, one may employ two and one-half pounds of cyanide of sodium. The same quantity of acid and water as directed for use with the potash compound will give best results.

Get from a grocer a hundred or more manila sacks, No. 8, 10, or 12. One will need two sacks for every three pounds of cyanide. Do not use the heavy paper sacks, so-called "sugar sacks." Cloth sacks must never be employed. These paper bags are to be doubled, one being carefully placed inside another. The cyanide, after being broken up, is placed in these sacks within an hour or two of the time when it is to be used, but must not be left in the sacks for any length of time—four hours or over night, for example. Torn sacks must be rejected.

When ready to fumigate, but not before, this cyanide should be done up in three-pound packages, use double manila bags—that is, one inside another—of such size as to permit the paper to be brought together and securely tied above the cyanide, without tearing. As many four-gallon crocks should be rented or purchased as there are packages of cyanide. If, however, the entire plant is not to be treated at one time, only sufficient jars are needed for the portion to be treated, since the same crocks

can be cleaned and used again. These crocks, after being cleaned, are in no way injured for household use later by having been used for this purpose.

Small mills—that is, mills in which there are not more than ten or twelve jars on a story—may be treated by dropping the charges by hand. We find that, under ordinary conditions prevailing in mills, about twenty-five seconds elapse between the dropping of the charge and the giving off of the fumes in fatal quantity. Where the floor is not too much obstructed by spouts or machinery, two level-headed men can walk rapidly from jar to jar, dropping a bag in each jar, and descend to the floor below without delay, closing the trap-door, or improvised cover of building paper, as they go down. Ten jars could easily be treated thus in less than twenty seconds. In other words, the men would be in the story below before the jar first treated began to give off a dangerous quantity of the gas, and as the gas always ascends, being lighter than air, operators on the floor below are, for a while, perfectly safe. Large mills, however, have to be strung.

Stringing a large mill consists in running stout cords, such as window cord, from the ground outside the building to various windows on each floor. One set of cords intended for lowering the cyanide is passed into the building, and the other set of cords so attached to the windows that they can be pulled down or lowered, after the process, thus insuring complete ventilation before the mill is entered.

The cord by which the cyanide is lowered into the crocks, after being passed through a hole in the window casing above the window, is continued through a strong screw-eye fastened to the ceiling or beam twelve or fifteen feet from the window. Smaller strings, each capable of supporting a weight of eight or ten pounds, are fastened to this cord after it has passed through the screw-eyes. The number of strings attached to all the cords entering a certain story should correspond to the number of three-pound packages of cyanide to be used on that floor. These smaller strings should run off in various directions, in order that the charge may be well distributed, care being taken to so arrange them as to avoid friction with any machinery. These strings should be passed through convenient screw-eyes, each one finally hanging to the floor at the point decided upon for the placing of a jar.

The first screw-eye near the window, through which the heavy cord passes, should be large enough to receive two of the heavier

cords; for, in order to insure the lowering of all packages, we tie a second cord so that it will not slip, securely to the first one. About eight feet from the first screw-eye, toward the window, pass it through the screw-eye, and attach a heavy weight to same. If the jars have been placed in position—and it is well that they should be before the next step, since this enables the workmen to locate at a glance the whereabouts of the perpendicular strings

FIG. 362.—The proper way to hang a bag above a jar.

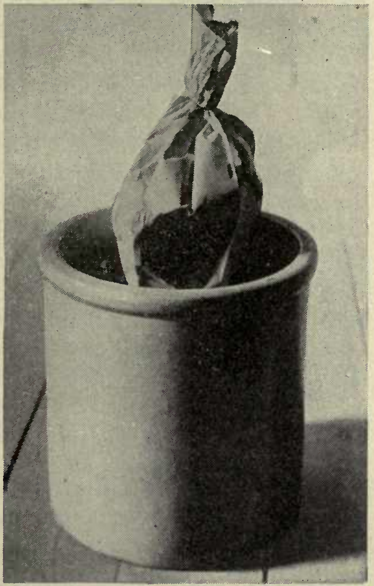


FIG. 363.—The wrong way to hang a bag above a jar.

—they must be *absolutely empty*, the preparation of the acid and water being left until later.

Reliable men should next be sent through the building with the packages of cyanide. They should tie one package *most securely* to each perpendicular string. The package should hang by its neck a good ten inches above the top of the jar (Figs. 362 and 363), and the men should bear in mind that the string will stretch, and act accordingly. The charges of cyanide being all tied, the next step is to place the water and acid in proper proportions in the jars. Each jar must first be moved away at least three feet from under its charge of cyanide. The necessity for this is evident.

Careful workmen then pour the right amount of water, six and three-fourths pounds for every three pounds of cyanide, into each jar. The acid should never be introduced first. Then, assuming that a three-pound charge of cyanide is to be used in each case, four and one-half pounds of the sulfuric acid is added to the water in each jar. If acid is introduced first and then the water, the jar is likely to crack. This must be done with care and every precaution taken to *keep all cyanide from proximity to the acid.* The fumes arising when the acid is added to the water are in no way dangerous. The next step is to carefully place each jar under its proper package of cyanide, *beginning at the top story and working down.* The bag should hang at least six inches above its jar, but not so high that it will not reach the acid when lowered from the outside of the building. The string used to suspend the bags *must be strong, and must have no weak places to invite accidents.*

Previous to this, or while it is being done, care should be taken that every window is tightly closed, and it is assumed that all cats which a miller may wish to save will have been previously removed from the building. The ground floor being reached, and *all men accounted for,* the doors of the mill should be closed, and the charges on every floor, beginning with the top story, lowered, by loosening the ropes connected with them and fastened outside. *Do not loosen any rope the freeing of which will open a window.* Further, if by chance any window has been overlooked, and is found to be open after the men have left the mill, *it is not safe to let any one enter the building to correct the oversight.*

Should, by any chance, a bag fall into a "loaded" jar by the breaking of a string, or through imperfect tying, the men working on that floor should leave the floor instantly for the floor next below, closing the door or opening through which they pass, and they must not enter that floor again until it has been thoroughly aired after treatment.

Time Required.—The charge is best set off at about 5 o'clock P.M., and the mill left closed until 7 A.M. next day; guards should be left about the building over night, and every necessary precaution taken to guard against accident through carelessness or ignorance. Do not fumigate if a strong wind is blowing; a perfectly still night is most desirable.

After the Fumigation.—At 6 or 7 the following morning open all doors and windows possible from the outside. After two hours' airing, the writer does not hesitate to enter any fumigated building.

The first thing to do, is to go over the plant and carefully remove from the proximity of the jars any charges which may not for any reason have "gone off." These bags of cyanide, if there are any, are carefully collected and removed to a place of safety. Then the workmen can remove and clean the jars. If the residue is solid, it can be removed with any suitable iron tool, and it is soluble in water. After the jars are thoroughly washed with hot water, they are perfectly good for any purpose whatever.

Theoretically, this liquid residue in jars is not poisonous, although it is still acid, and will burn skin or clothes. But the chemical action may not have been complete; hence great care should be used in disposing of it. A very good plan is to dig a hole in the ash heap or in the earth, dump the contents of each jar therein, and cover the hole after all jars are emptied. The jars should afterward be thoroughly cleaned and scrubbed.

If by any chance any cyanide should have been overlooked and should drop into a jar when a workman is by it, he and others in the proximity should leave that floor instantly, closing doors behind them. The windows being open at this time, the poisonous fumes would soon be carried away.

Limits of the Effects.—Hydrocyanic acid gas will not penetrate large bins of grain; nor will it enter fine stuff like flour, beyond a very short distance, possibly an inch. It therefore behooves a miller to take away and burn any refuse, or fine matter on the floors or in the spouts which he has reason to believe is infested. Marketable mill stuff, bran, etc., in sacks should be shipped before treatment or immediately after, that the mill may not be reinfested from contaminated material. All machines, spouts, elevators, etc., should be left open to allow of free entrance of gas. Since this gas is lighter than air; it would not be safe for one to drop packages of cyanide into jars of acid in a basement and then endeavor to leave by ascending stairs. Hence, even when we drop by hand, we frequently string the basement.

What Constitutes Success in Treating a Mill.—It must be borne in mind that a mill sufficiently infested to call for treatment necessarily contains many millions of the moths in some stage. A few "worms" or pupæ concealed in some crack on the side of a window or elsewhere may escape the deadly fumes, but the finding of five, ten, or twenty live worms after the fumigation by no means indicates failure. Far from it; for, eliminating all unfavorable conditions, it might take several years for a mill to become suffi-

ciently reinfested from this source alone to need another treatment.

The above is, in brief, the method of procedure in fumigating mills for the flour moth. The gas is a safe and most efficient agent when used with care by those familiar with its nature. One good whiff of it, however, would probably be fatal to any human being; hence, *its use should never be entrusted to one not familiar with it.*

Rats or mice perish if they come in contact with the fumes. Its presence can be detected even in minute quantities by the odor, which is that of the kernel of peach pits.

Opinions of Millers.—The writer is in receipt of many statements from millers testifying to the efficacy of this method; a few of these are repeated here:

From the owner of a badly infested mill: "The work seems to have been a success, and we certainly could not have continued running without the treatment. I have been around the mill this morning, making a personal examination of the results of the work; have taken out of spouts a large amount of webbing and worms, and on a careful examination do not find a single live worm or moth, and some of the masses in the spouts were possibly an inch thick."

Another mill owner, whose plant was perhaps one of the worst in this connection ever seen, says: "The process seems to be a most successful one where mills are infested with various pests."

The head miller of a seriously infested milling plant in Illinois writes: "The gas made a clean sweep of the flour moths in our mill. I have not seen one now in two months, and am keeping a sharp lookout for them all the time. This seems a remarkable condition to one familiar with the premises and knowing how well they were established in the mill."

Another miller writes: "We have been using hydrocyanic acid gas for a number of years with very satisfactory results."

An Illinois firm writes: "The Monday after the treatment we cleaned out everything thoroughly, and at that time found just one live moth. . . . We are well pleased with the result of fumigation, and have nothing to regret except the fact that we did not go at it four years ago."

Another: "Have used this method in our mills for the last four or five years, and find it very satisfactory, especially when care is taken in making proper preparations."

One of the best proofs of the efficacy of this method was shown in the fact of a very badly infested Illinois mill remaining absolutely free of the moth for fourteen months after being fumigated,

at which time the mill was closed because of the owner giving up the business. This can mean but one thing, namely, that the flour moth in that mill, in every stage of its life, including that of the eggs, was killed by the process.

A miller must not expect, however, that one treatment will necessarily eradicate all and every pest in the mill. There is the chance that the figuring of the amount required may not have been accurate, or that the mill may not have been properly cleaned beforehand; or that it may become reinfested from some source.

Effect on Other Insects.—A few of our mill pests do not yield readily to this treatment, which is so efficacious against the flour moth. Fortunately they are not insects which are particularly troublesome. We frequently find some of the little red beetles, flour beetles, sometimes erroneously called "weevils," alive in a mill after fumigation. The same is true of the flattish, yellowish-brown "worms" (meal worms) which later turn into black beetles. These two pests are apt to bury themselves in inaccessible places, and in the midst of fine stuff, thereby precluding the possibility of the gas reaching them. However, these insects are of small importance compared with the flour moth, against which this process is especially directed.

A few observations made in the course of the work may well be given here for the information of millers.

1. The size of lumps of cyanide makes but little difference, except that the pieces, as shown in the illustration (Fig. 364), should be of convenient size for doing up in bags. The corners of small pieces do not push through the paper as readily as do the corners of large pieces.

2. Hot and cool acid appear to act with equal rapidity upon the uncovered cyanide, but the temperature of the liquid makes a great difference in the matter of penetrating a double paper sack—the cooler liquid penetrating the paper much more slowly.

3. The make of sacks appears to cause no difference in the time required for the acid to penetrate to the cyanide, so long as the sacks are of manila, and are not of heavy material, such as is used for sugar sacks. The latter should be avoided. Cloth sacks should never be used.

4. Mills should never be fumigated for less time than one night.

5. Twenty-five seconds elapsing between the dropping of cyanide and the first giving off of gas in a fatal amount is a conservative time estimate, resulting from practical tests with the

liquid at a temperature of 140 degrees F. to 180 degrees F. This will be approximately the temperature of the liquid up to one-half hour after mixing the acid and water, with the mill at ordinary temperature.

6. Experiments in the laboratory and practical work in many mills indicate that eggs of the flour moth are killed by this gas, and that other stages of the insect are reached and killed even when covered by an inch or more of webbing.

Precautions.—1. Calculations as to the cubical contents of each floor to be fumigated must be absolutely accurate.

2. Get only the best material; a poor grade of cyanide or acid can not be relied upon.

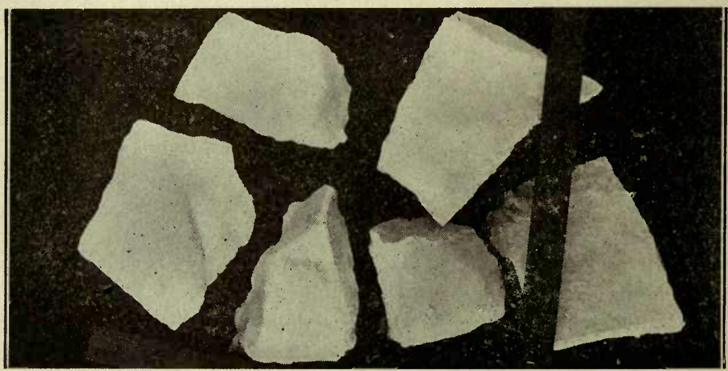


Fig. 364.—Pieces of cyanide should be from two to four inches in diameter.

3. Put on the work only a few picked men, selecting them from among the most intelligent of your employes.

4. Take every measure possible to prevent the cyanide from coming in contact with the acid until the critical moment when such contact is desired. Be sure that each step of the process has been carefully studied beforehand. Do not hang bags as shown in figure 363.

5. Provide for thorough ventilation from the outside. Do not enter the mill until it has been well aired for at least two hours.

6. Removal of the jars from the building after the operation and the disposing of the residue in a safe place, call for care, and should not be intrusted to men who are careless or ignorant as to the nature of the gas. They should be cautioned to avoid a jar which bubbles, and should at all times keep their faces away

from the jars they are handling. This residue, if the chemical action has been complete, is not poisonous, but it is acid, and it is always best to "keep on the safe side." It should therefore be placed where it will do no harm.

7. The lumps of cyanide, when placed in the bags, should be approximately between two and four inches in diameter.

8. If one must deal with returned sacks, they should be fumigated before being placed in mill, as they are a prolific source of infestation.

9. Use four-gallon jars, never three or five, if it is avoidable. Three-gallon crocks frequently boil over.

10. For his own satisfaction in doing the work thoroughly, and for the safety of his employees, no miller should undertake this operation without having first become conversant with every step of the process.

11. Hydrocyanic acid gas penetrates readily through small cracks and crevices. A mill in close juxtaposition with another building not controlled by the miller, or within ten or twelve feet of another building occupied during the process, would present difficulties.

12. Although this gas is not explosive at the strength above recommended, it would appear to be a desirable precaution to turn off lights and draw fires (if boiler or engine-room is included or is reached by the gas) before the operation.

13. In ordering material get more than enough, for if one finds himself short at the last moment, and is at a distance from the source of supplies, he certainly is in a predicament. Further, order in time. Railroad companies will not ordinarily freight acid in carboys with general merchandise; they may hold the acid several days or a week, waiting for an oil car.

QUESTIONS

1. Enumerate, in order of their importance, the insect pests frequently found in a flour mill and warehouse.
2. Do the same for those which are peculiar to granaries and elevators.
3. Give description, life history, and habits of the Mediterranean flour moth.
4. Describe in detail method of fumigation for mill pests with hydrocyanic acid gas.
5. How would you proceed to eradicate the granary weevil from a bin or elevator?
6. What methods should be employed by a housekeeper who finds her flour bin infested with the confused flour beetle?
7. What pests mentioned in this chapter have you ever found in stored products?

CHAPTER XIX

OUR INSECT FRIENDS

NOT all insects are injurious. Some are decidedly useful, and the useful species may be classified in two groups:

1. Those directly beneficial to man, such as the silkworm, honey-bee, lac insect, from whose activities we get shellac; cochineal insect, the source of a beautiful dye; blister beetle, used in medicine.

Grasshoppers, classified as injurious insects, were used as food

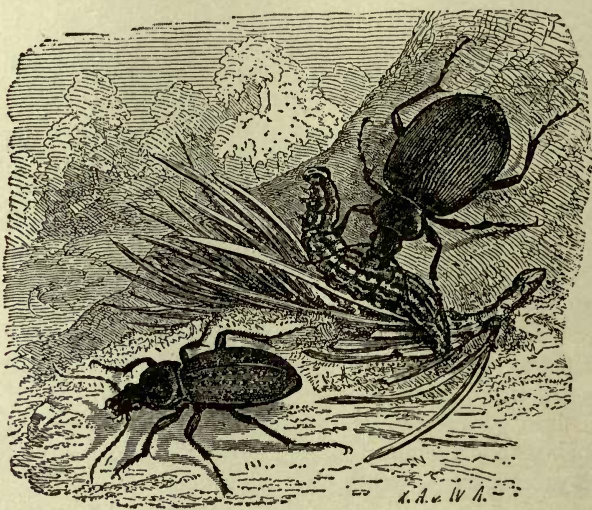


FIG. 365.—Ground beetles. (After Brehm.)

by some Indians, and became, to that extent, useful. White grubs have been recently eaten and declared palatable.

2. Those which, by destroying other harmful insects, are indirectly beneficial. Again, the indirectly beneficial insects may be further divided into four groups:

(*a*) The predaceous insects, which seize and devour other species. They include: The ground beetles (Fig. 365), tiger beetles, lady beetles (Figs. 366 and 367), or so-called "lady

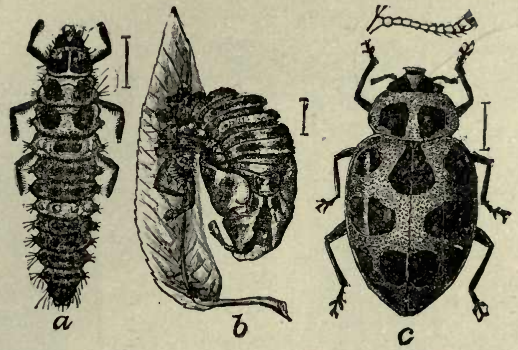


FIG. 366.—Lady beetles ("lady birds," "lady bugs") or coccinellids; *a*, larva; *b*, pupa; *c*, imago; all much enlarged. (U. S. Bu. Ent.)

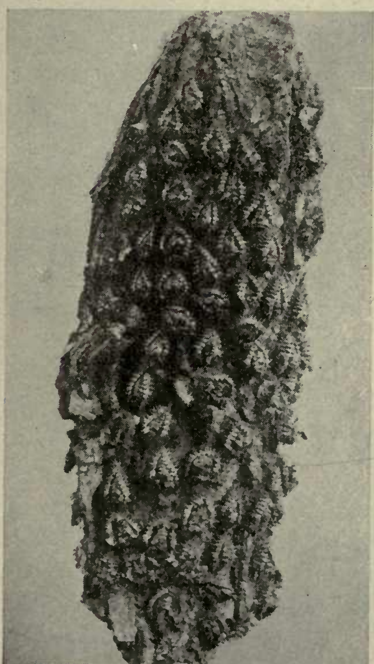


FIG. 367.—Skins of lady beetle larvæ on bark, split open and showing pupæ within.

FIG. 368.—Syrphus flies; 1 and 2, adults; 3, larvæ eating plant lice; lower figure contracted larva; 5 and 6, view of larva, enlarged, and pupa.

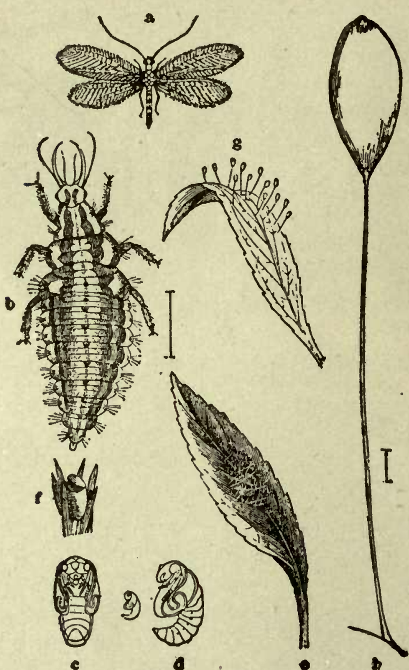


Fig. 369.—A lace-winged fly: *a*, enemy of plant lice, natural size; *b*, larva, greatly enlarged *c* and *d*, pupa; *e*, web on leaf; *f*, cocoon; *g*, egg cluster; *h*, egg on stalk, greatly enlarged.

Fig. 370.—Ichneumon parasites attacking caterpillars.

FIG. 371.—Caterpillar from which larval parasites are emerging. The adult chalcid fly is shown on right.

birds," which with their larvæ prey upon plant lice and scale insects; syrphus flies (Fig. 368), whose young have a similar diet; the lace-winged fly (Fig. 369) or aphis lion, some wasps and others.

(*b*) There are parasitic forms which lay eggs on or in other insects or their eggs. The most notable group of parasites is the *Ichneumonidæ* (Fig. 370 illustrates a large species), a hymenopterous family containing over 10,000 species, all parasites. The *Chalcididæ* (Fig. 371), also belonging to the Hymenoptera, includes about 4000 species. The *Braconidæ* and the *Proctotrypidæ.* The members of the latter family are very small, and are chiefly parasitic on eggs of insects. Among the *Diptera* we have the bee flies (Fig. 372) and the *Tachinidæ*, very abundant in number of species. Their white eggs are frequently seen on tent caterpillars and army worms (Fig. 373).

(*c*) Among the indirectly beneficial insects we ought also to include several

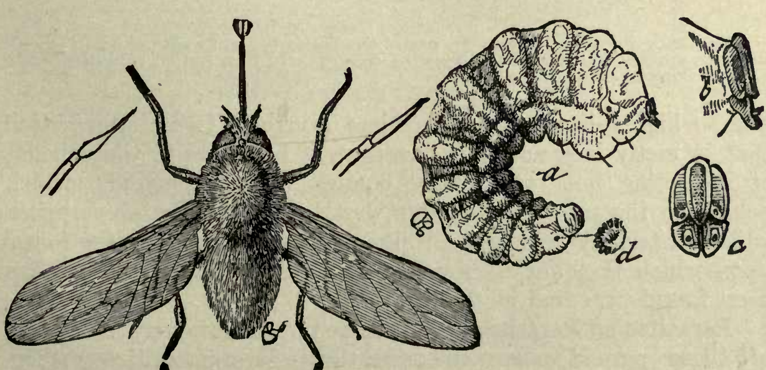


FIG. 372.—*S. oreas*, a bombyliid or bee fly. The larvæ of some members of the family are parasitic in the egg pockets of grasshoppers; *a*, larva; *b*, head of same from the side; *c*, same from the front; *d*, preanal spiracle. (After Riley.)

forms of scavengers: The burying beetles remove carrion, offensive both to the eye and nose. The flesh fly larvæ and others devour meat which either is or will be putrid. Pomace flies feed upon decaying fruit. Flies and beetles which breed in and feed upon excrement should also be regarded as, in a way, beneficial.

(*d*) As plant pollinators many insects are of invaluable assistance to man, cross-fertilizing many varieties of fruit which might ordinarily be sterile.

Parasitic Insects.—Of all beneficial forms, however, the parasitic insects, from an economic standpoint, are the most important,

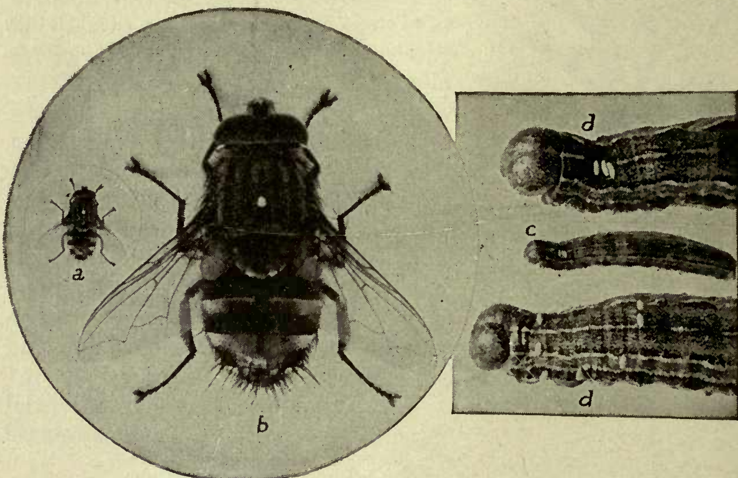


Fig. 373.—Red-tailed tachina fly, one of the *Tachinidæ; a*, fly natural size; *b*, fly enlarged; *c*, army worm, natural size, upon which eggs have been laid; *d*, parasitized army worms, enlarged. (After Slingerland.)

and so highly is their work against injurious forms appreciated that in many instances our government has gone to the expense of importing not only "lady beetles," or Coccinellids, which belong to the predaceous group, but large numbers of parasites which materially reduce the ranks of the various injurious forms upon which they prey. Rearing parasites for economic use has been found practical in this country.

Parasites on Parasites.—It is to be noted, however, that many of these parasites are in turn themselves parasitized, their parasites being referred to as *secondary parasites*. Even the secondary parasites are frequently the victims of *tertiary parasites*, and

sometimes these, though very rarely, may possibly be attacked by *quarternary parasites*. This is called *hyperparasitism*. This condition of affairs is sometimes humorously described thus:

> Great fleas have little fleas
> Upon their backs to bite 'em,
> And little fleas have lesser fleas,
> And so *ad infinitum*.

Examples.—The Hessian fly, which is one of our worst wheat pests, is kept within bounds almost entirely through the agency of native parasites. In 1895 a severe outbreak of the white-marked tussock moth injured a large number of shade trees in Washington, but more than 97 per cent of these caterpillars were destroyed by parasites, and the pest did not appear the next year. L. O. Howard, of the United States Bureau of Entomology, states that in 1880 Hubbard found "that a minute parasite, *Trichogramma pretiosa*, alone and unaided, almost annihilated the fifth brood of the cotton worm in Florida, fully 90 per cent of the eggs of this crop enemy being infested by the parasite."

Summarizing, we can classify beneficial insects under the following heads and sub-heads:

1. Directly Beneficial.
    - A. Insects themselves.
        - *a*. Food for Indians, such as Grubs, Grasshoppers, or "Locusts," and some Maggots.
        - *b*. Food for Animals; for Birds, Poultry, Gophers, Skunks.
        - *c*. Medicine: "Spanish Fly."
    - B. Products of Insects.
        - *a*. Honey from Honey-bees.
        - *b*. Shellac from Lac Insect.
        - *c*. Silk from Silkworm Moth.
        - *d*. Ink from Galls. (In former days.)
        - *e*. Cochineal.
2. Indirectly Beneficial.
    - *a*. Pollination of Fruit Trees, Berries, Clover, and other plants.
    - *b*. Removers of Carrion and Waste Matter: Flies, Carrion Beetle, Burying Beetle.
    - *c*. Predaceous: Ground Beetles, Digger Wasps, Ladybird Beetles, Tiger Beetles, Syrphus Flies, Lace-winged Flies.
    - *d*. Parasitic: Large 2- and 4-winged; Small 4-winged; Tiny Egg Parasites.

Diseases of Insects.—We can hardly dismiss this subject without consideration of two other valuable allies of man in his fight against injurious insects, namely, bacterial and fungous

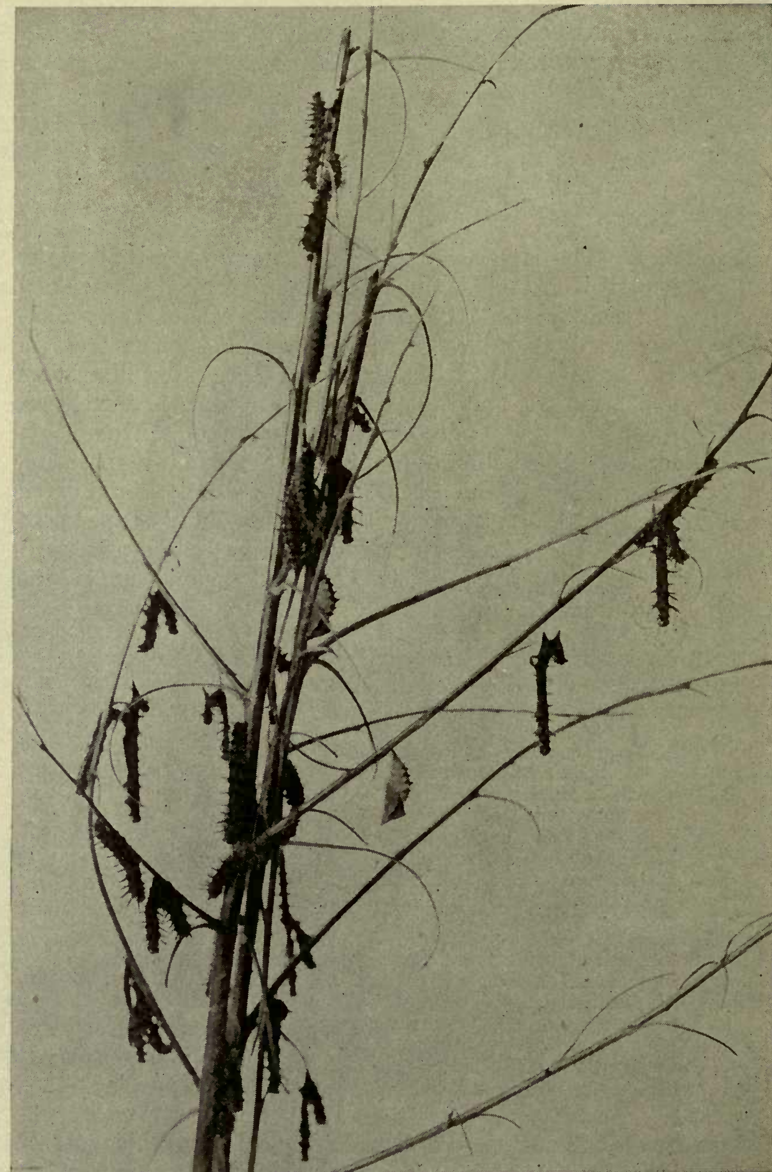


Fig. 374.—Caterpillars killed by a bacterial disease.

diseases, which at times attack insect pests of agriculture. Figure 374 represents caterpillars killed by a bacterial disease. Figure 375 shows a grasshopper which has died on account of a disease. In the former case the dead insects hang limp and for a time after death are filled with fluid, denoting bacterial activity. The body contents of an insect killed by a fungus are comparatively dry.

Fig. 375.—A grasshopper killed by a fungus.

At times one finds thousands of chinch bugs in the autumn killed by a fungus originating in the field. Several attempts were made some years ago to introduce among chinch bugs a fungus prepared in the laboratory, with the hope that their numbers might be materially reduced thereby. This did not prove practical, since, apart from the difficulties attendant upon its distribution, it required damp weather in order to grow, and under such conditions we find a fungous disease originating naturally in the field attacking the insects in question.

QUESTIONS

1. Name four directly beneficial insects, and state why each is useful.
2. What is a predaceous insect? Name four useful forms in this group.
3. What is a parasitic insect? Give four examples.
4. How, in this connection, would you classify burying beetles, flesh-flies, dung beetles, grasshoppers, and white grubs?
5. How do bacterial and fungous diseases affect insects?

CHAPTER XX

THE RELATIONS OF BIRDS TO AGRICULTURE

Disregarding any sentimental views upon birds caused by their song and beauty, and basing our opinions as to their usefulness or the contrary purely upon a study of their food habits at different seasons and in different years, we may safely say that almost all of our common birds, including a goodly number of hawks and owls, the so-called "birds of prey," are useful to the agriculturist and fruit-raiser. Some are more so than others. A few are of doubtful utility. A still smaller number, representing a very small proportion of our bird fauna, we now regard, in the light of our present knowledge, as injurious. It is possible that additional investigation may cause us to entertain a different opinion of the latter.

Killing Useful Birds.—A farmer, orchardist, berry-raiser, or truck gardener has a perfect right to protect his crops from excessive bird injury. We have known occasions where resort to a shotgun was justifiable. But, in such cases, one should be absolutely sure that the bird he seeks to destroy is really guilty; that the injury caused is serious; and, particularly, that the benefits accruing from the destruction of a large number of insects on the part of the bird in question, during the nesting season, do not more than compensate for the few berries or small amount of other fruit or of garden or farm crop destroyed. For this information the agriculturist has to rely mainly upon the results of the studies of experts in this line. It requires long and careful observations and the examination of a large series of birds' stomachs to place this matter upon even an approximately accurate basis.

Encouraging Nesting.—In this connection, we should note that the parent birds secure an enormous number of insects which form the main part of the food of nestlings, as near the nest as possible. If the nest is near, more trips are made each day; and consequently, more insects are consumed. A bird nesting a mile away from a berry patch is not going to cover that distance seeking for insects if it can get them near at hand. Therefore, it behooves the agriculturist to encourage nesting of birds upon his own place.

Teaching Boys to Protect Birds.—Teachers in our city and country schools have an excellent opportunity to inculcate in the minds of their boys a desire to study the habits of birds and to discourage the maiming and killing of song birds and the destruction of their nests and eggs. Usually the small boy who would "make a collection" of birds' eggs wishes to do so because they are attractive to him, partly by their color and partly, perhaps, by the difficulties involved in securing them. No doubt he is also influenced by a desire "to collect," which sometimes makes imperative demands upon both young and old. The loss to agriculture by such collections is decidedly great. This loss is avoidable if the boy's ambitions can be turned into other channels. Acts of this kind, egg-collecting without a license, and the killing of song birds, are, for the most part, punishable by law. But if the child can be led to observe these laws by having an intelligent interest in the birds themselves, the result is better than if fear is the instigating cause. We should emphasize the need upon the part of both adults and young of a careful and discriminating judgment of birds based upon their food habits before condemning them.

Making Friends of the Birds.—We should encourage, in every way possible, their continued presence on the farm, in the garden, and in the orchard. We can do this in many ways: (1) By making boxes for wrens, bluebirds, and martins. (2) By exposing material used in nest-building. (3) By winter feeding. (4) By fostering a wise and humane policy toward our feathered associates. (5) By providing watering places. (6) By planting fruit-bearing shrubs.

The recent enactment of laws by Congress protecting birds during their migration is one of the best evidences of the growth of a higher and, at the same time, a more practical sentiment in this direction.

Classification of Birds.—Birds belong to the Class Aves of the Vertebrate Phylum. The Class is divided by some ornithologists into eleven Orders. The six of most interest, perhaps, to the farmer are:

Insessores (Passeres) or Perchers.
Raptores (Accipitres and Striges), birds of prey.
Picariæ, woodpeckers and others.
Gallinæ grouse, partridge, quail and common fowl.
Coccyges, cuckoos and kingfishers.
Herodiones, herons, and bitterns.

Families of Perchers.—The Orders, in turn, contain groups known as Families, hence in the Order Insessores we have many groups represented in part by the ten families given below:

Tyrannidæ, or fly catchers.
Corvidæ, crows, jays and magpies.
Icteridæ, orioles, blackbirds and meadow larks.
Fringillidæ, sparrows and finches.
Ampelidæ, wax wings.
Vireonidæ, vireos.
Mniotiltidæ, wood warblers.
Turdidæ, thrushes.
Troglodytidæ, wrens.
Paridæ, chickadee, titmice, and others.

Genera and Species.—As in other groups of animals, each family is divided into genera, each genus made up of a number of species, and frequently species have sub-species, or varieties based upon minor variations from the type.

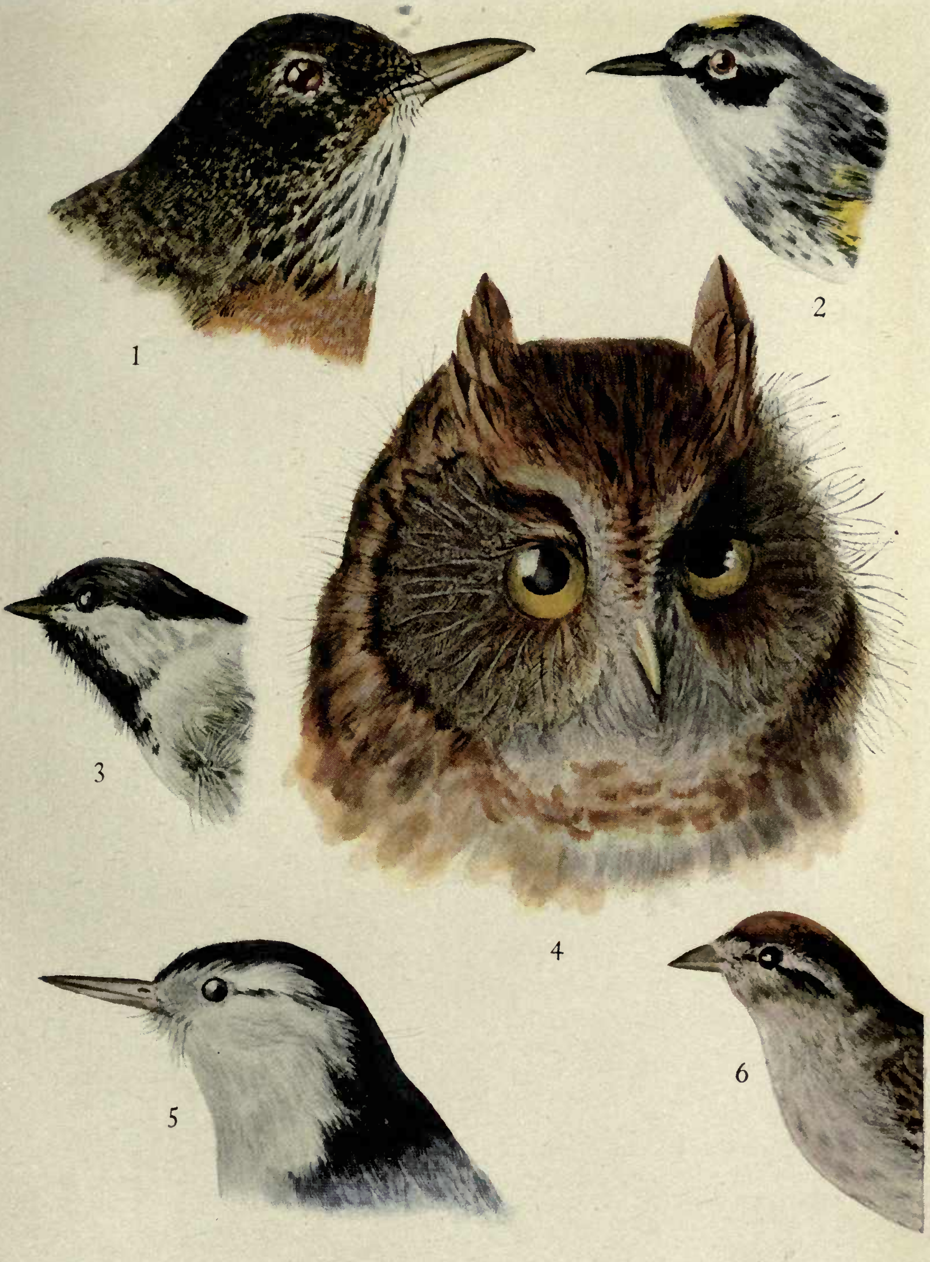
In the following pages it has seemed best to select from the Class certain of the more common birds—for the most part important to the farmer, because of their insect-eating habits, or in some instances because of injurious traits. It appears more suitable for the purpose at hand to describe these without reference to scientific groupings.

We have named only a portion of the Orders in the Class and also limited our list of families occurring in one order to those which contain the species described in the following pages.

Robin (Plate 2, Fig. 1).—What would a country home be without robins on the lawn! As a rule, the robin, which is really a thrush, is fairly useful; but a large part of its food is fruit, and it eats many useful beetles. Because of our general attachment to the bird, agriculturists will probably try every possible protective means before having recourse to the shotgun when fruit is to be saved.

Individuals of this species are found in the North frequently very late in the fall, and occasionally, where evergreen thickets afford shelter, even in the winter. Generally they begin to arrive in the northern states the latter part of March or early in April —welcome harbingers of spring. Two broods are reared.

Beetles constitute a large part of the robin's diet during the summer. Beal (U. S. Biol. Survey, Bul. 171) gives a list of nearly one hundred plants, the seeds of which have been found in robins' stomachs. Most prominent among them are blueberry, dogwood,



I. L. WOOD, DEL. BUR. ENGRAVING, MPLS.

Plate 2, SOME USEFUL BIRDS

1. American Robin. 2. Myrtle Warbler or Yellow-rumped Warbler. 3. Chickadee. 4. Screech Owl. 5. White-bellied Nuthatch. 6. Chipping Sparrow; "Chippie.'

woodbine, sumach, blackberry, cherry (domestic and wild), cedar, mulberry, etc. Since most of these seeds pass through the alimentary canal with fertility unimpaired, the robin is a disseminator of these plants.

A western variety of robin is a resident in western Oregon the entire year. Its habits are similar to the eastern congener. Closely allied to these birds is the varied thrush or Oregon robin, also a resident on the Pacific coast through the entire year.

The Varied Thrush or Oregon Robin.—This beautiful and somewhat retiring bird is common on the Pacific coast, ranging as far north as Alaska. It has a back of slate color, with orange-brown markings on shoulder; a broad black collar stretches across the breast and runs up on either side of neck and head; the under parts are orange, as is also a strip over the eye. This bird is nearly ten inches long. It nests in bushes. It is charged with no bad habits.

Fig. 376.—Cat-bird. (After Fuertes.)

The Cat-Bird.—Among the birds of doubtful utility, we place with reluctance our friend, the cat-bird. Although it has a delightful song, equal or surpassing the brown thrush, it, nevertheless, is not of great assistance to the farmer. It eats some insects, it is true, but later in the season "these insects are largely replaced by cherries, currants, raspberries, and strawberries. Three-fourths of the food of eleven July cat-birds consisted of small fruits, mostly (sixty-four per cent) blackberries. Nine per cent of beetles had been taken, most of them being predaceous (beneficial)."[1]

Nevertheless, on account of its song and friendliness, and

[1] From observations by Forbes, of Illinois, in "Birds in Their Relation to Man."

from the fact that it eats some injurious insects, the cat-bird will doubtless continue to be protected, except in cases of particularly flagrant destructiveness. Figure 376 is an excellent illustration of the species.

The Brown Thrush or Brown Thrasher.—The illustration here given (Fig. 377) is sufficient to enable us to recognize this very common bird of our thickets and fields. The bird is rufous brown above, with black spots on a white ground below. Its colors

FIG. 377.—Brown thrush. (After Fuertes.)

and conspicuously long tail make it a notable object when it seeks a prominent position on a lofty branch, preparatory to singing.

Its song, while striking, will not compare, we believe, with those of the wood thrush or Wilson thrush, nor with that of the cat-bird. One of its chief charms, perhaps, lies in the fact that it is an accompaniment of the welcome spring weather. We have been so struck by the little rhyme credited to "Olive" in "Citizen Bird," which certainly is very descriptive of its habits and song, that we venture to repeat it here:

My creamy breast is speckled
(Perhaps you'd call it freckled)
Black and brown.

My pliant russet tail
Beats like a frantic flail,
Up and down.

In the top branch of a tree
You may chance to glance at me,
When I sing.

But I'm very, very shy,
When I silently float by,
On the wing.

Whew there! Hi there! Such a clatter!
What's the matter—what's the matter?
Really, really?

Digging, delving, raking, sowing,
Corn is sprouting, corn is growing,
Plant it, plant it!
Gather it, gather it!
Thresh it, thresh it!
Hide it, hide it, do!
(I see it—and you.)

Oh! I'm that famous scratcher,
H-a-r-p-o-r-h-y-n-c-h-u-s r-u-f-u-s—Thrasher.
Cloaked in brown.

Its Food.—While the brown thrush may take a little fruit or grain, it is a good insect eater. As a ground feeder, scratching among fallen leaves, it picks up many injurious insects, and, it must be admitted, some useful forms as well—the ground beetles, for example.

Wood Thrush and Veery.—The first-named bird, a beautiful singer, is about eight and one-fourth inches long, with distinct, sharply outlined, large, round, black spots on the whitish breast and under parts (Fig. 378).

A closely allied thrush and also a beautiful singer is the Wilson thrush or veery (Fig. 379). The latter species is a smaller bird, a little over seven inches long; the white breast is more or less tinged with cream and dotted with small, somewhat indistinct, brownish, wedge-shaped spots.

The upper parts of both of these birds are brown, but in the veery the colors are not as bright as in the wood thrush. Both lay greenish-blue eggs in a coarse nest, modelled somewhat after

the nest of the robin. The nest of the veery may be on or close to the ground. The beautiful songs of both of these birds, coming from the dense woods, if once heard are never forgotten.

Food Habits.—They are both important insect eaters. In fact, the entire thrush family must be credited with being benefactors of the farmer and fruit-raiser. But occasional members may be attracted to berries and fruit, notably in the case of the robin. Forbes, after a somewhat exhaustive examination of their food habits, states that sixty-one per cent of the food of thrushes consists of insects.

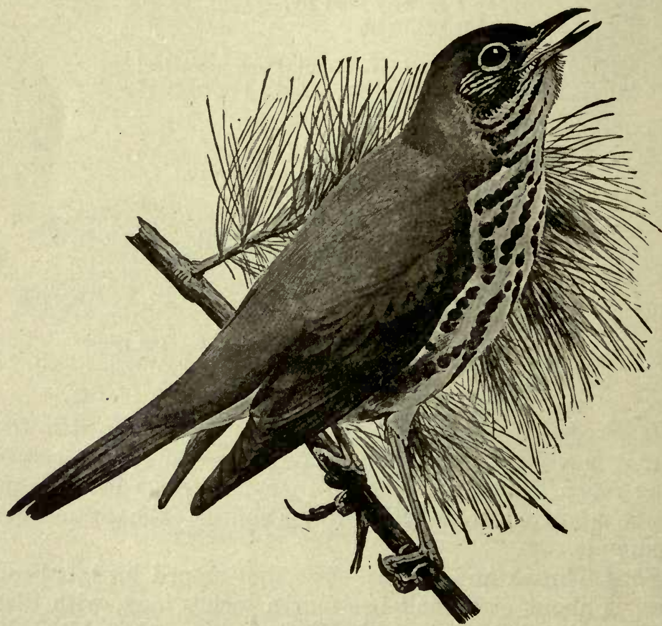


Fig. 378.—Wood thrush. (After Fuertes.)

Mocking-Bird.—This species, distinctively an American bird, is rarely seen as far north as New England, but ranges through the southern United States, from the Atlantic to the Pacific, and is particularly abundant in the South Atlantic and Gulf states. It is referred to as the "prince of musicians" among birds, and deserves the title. Individuals in captivity appear to improve their song by education and mimicry until there is hardly a songster whose notes may not be repeated.

The mocking-bird owes its popularity almost entirely to its powers of song, for its gray color with whitish under parts is not particularly attractive.

It is about nine to ten inches long, one-half of which length is represented by the tail. The somewhat bulky and misshapen nest is found in bushes and low trees. It has two or three broods in a season. Its food habits are similar to other members of the thrush family.

Bluebird (Plate 4, Fig. 19).—The common bluebird is too well known to need detailed description. It is found in many

FIG. 379.—Wilson thrush or veery. (After Fuertes.)

parts of the United States, Canada, Mexico, and parts of Central America. It is of wide distribution, from the Atlantic to the Rockies, and from Canada to the Gulf of Mexico. The bird's upper parts, including wings and tail, are bright blue; the breast, throat, and sides are reddish. The length is seven inches.

Its note is among the first to be heard in the spring and one of the last in the fall, at which latter time we associate it with the falling leaves of Indian summer. To the writer its note in the fall has always appeared to take on additional sadness, as if lamenting the dying of the year.

It nests in hollow trees and in boxes erected in suitable places. Its nesting should be encouraged by providing it with plenty of such opportunities for housekeeping.

An examination of two hundred and five stomachs showed that seventy-six per cent of the food consisted of insects and their allies, while twenty-four per cent was made up of vegetable substance. Beetles constituted twenty-eight per cent of the whole food; grasshoppers, twenty-two; caterpillars, eleven; and various insects, including spiders, comprised the remainder of the diet. All these insects are more or less harmful, except a few predaceous beetles, which amount to eight per cent. Forbes, of Illinois, examined one hundred and eight specimens secured in every month except November and January. Results of these examinations prove that, although the bluebird eats some insects which are beneficial, and occasionally takes a raspberry or gooseberry, it consumes enormous numbers of injurious insects, cut worms, army worms, moths, grasshoppers, and crickets. It is undoubtedly a beneficial bird.

Chickadee (Plate 2, Fig. 3).—This familiar bird is found as a resident throughout the northern part of the United States, and in Canada and Alaska. It is dear to us because of its cheerful activity in the cold of winter, when almost all other bird friends have left us.

Importance.—From an economic standpoint it is a great benefactor, for not only does it consume large numbers of insects in summer, but more than one-half the winter food consists of insects and their eggs. The eggs of plant lice make up one-fifth of the entire food. In fact, the destruction of these eggs on fruit and shade trees is the chief beneficial work of this bird in the winter, and the good it does in this way must not be underestimated. Examinations of the stomachs or crops of these birds have shown that sometimes more than four hundred and fifty eggs of plant lice are consumed by one bird in one day. Eggs of canker worms and tent caterpillars are also eaten. Four stomachs or crops examined showed, as the result of a single day's feeding, one thousand and twenty-eight eggs of canker worms. Four others contained about six hundred eggs of canker worms and a hundred and five mature female canker worms. Surely, if any bird deserves protection, it is this one.

Such a familiar bird hardly calls for a description. The head, back of neck, and throat are black; sides of head and neck, whitish;

breast, white; sides, washed with brownish yellow. The length is about five and one-half inches.

It nests in old stumps and decayed trees, preferably birch; the holes are generally not far from the ground.

In addition to its cheerful "chick-a-dee-dee," it has a number of other notes, some of them extremely musical. (See figure 380, and plate 4.)

House Wren.—This charming little bird (Fig. 381), always ready to accept hospitality from our citizens, feeds almost entirely upon insects. Spiders also form a large part of its diet.

It will readily occupy any small bird-house provided for it.

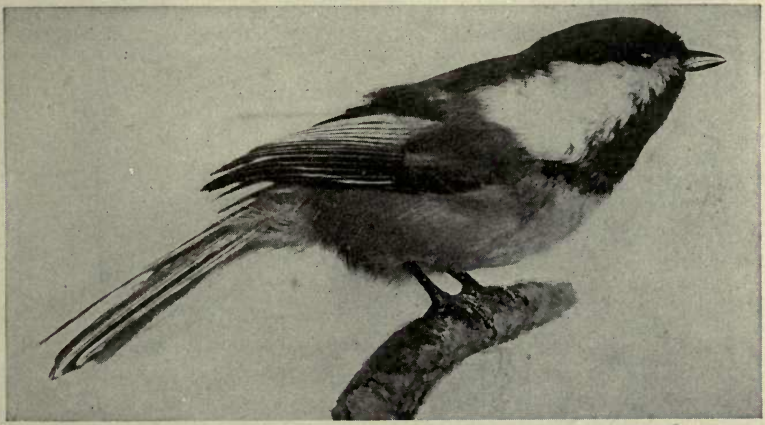


Fig. 380.—Chickadee.

The entrance to such a bird-houses should be exactly the size of a quarter of a dollar, which allows the wren to enter but keeps out the English sparrow.

The wren reaches the northern tier of states about the last of April.

White-Breasted Nut-Hatch (Plate 2, Fig. 5).—It is one of the few of our birds which is commonly seen "climbing" down as well as up a tree. It is about six inches long. It is gray, with white under parts; top of head, black; back, bluish. This species ranges practically all over the entire United States and Mexico.

Over one-half of its food consists of insects. It nests in holes in trees, and suitable nests can be made to imitate these.

This is one of the few birds which remain in the most northern

states over winter, at which time it frequently associates with chickadees, downy woodpeckers, kinglets, and brown creepers.

Its rather coarse note, frequently repeated, has been likened to the word "yank" repeated with a nasal sound.

A close cousin of this bird, the red-breasted nut-hatch, has a somewhat more northerly range.

Brown Creeper (Plate 3, Fig. 10).—This inconspicuous, active bird is found in the North throughout the entire year. It is to be ranked among our most useful assistants in keeping down injurious insects, for it eats many insects in the hibernating stage in winter, besides consuming large numbers of insect eggs, which would otherwise hatch in the spring. It appears to be always in

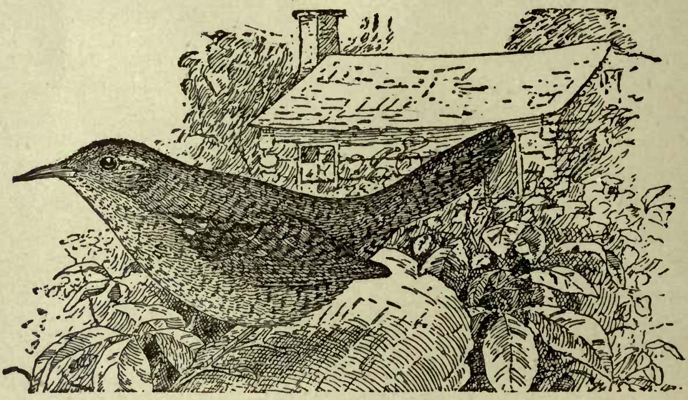


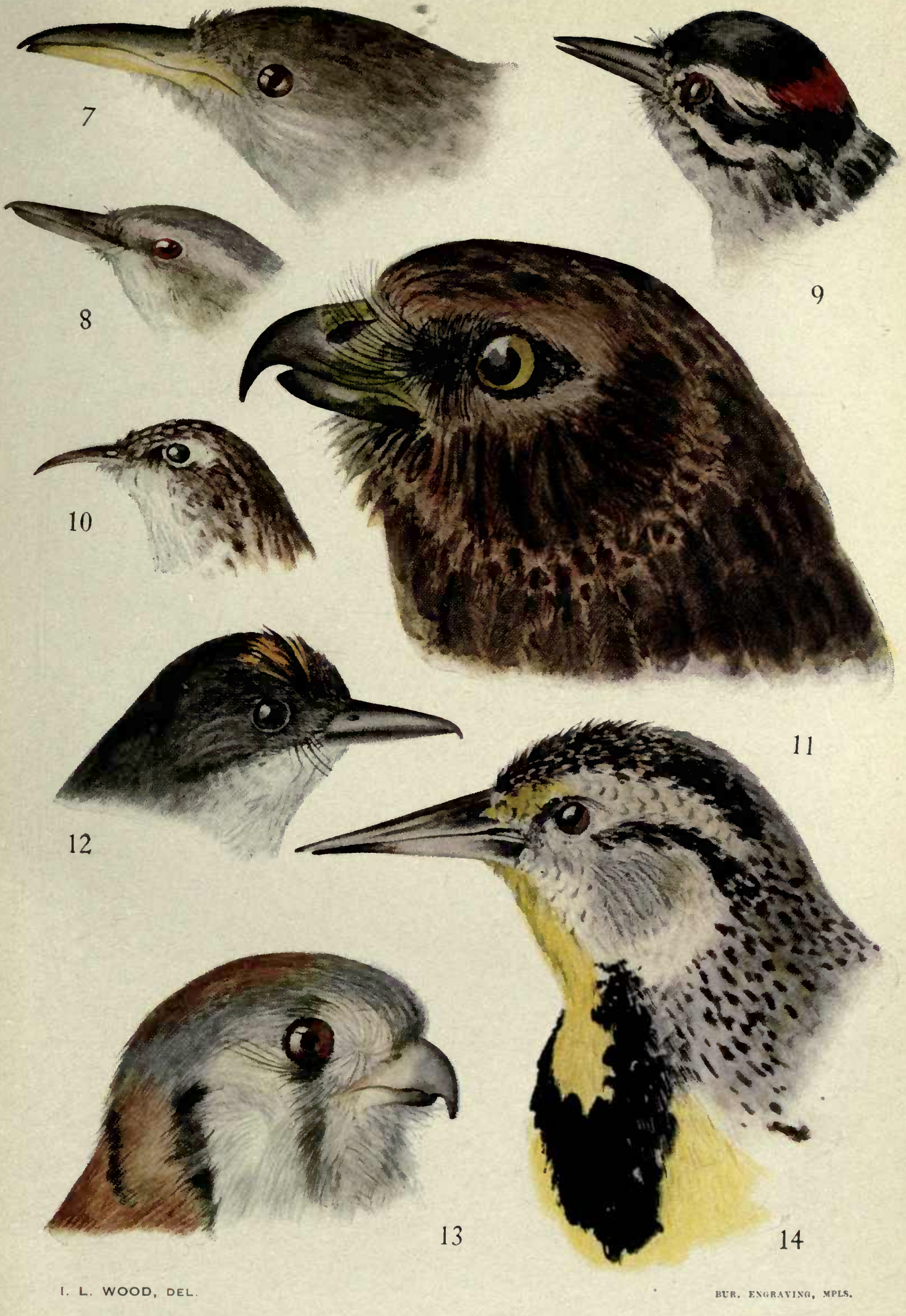
Fig. 381.—House wren. (U. S. Biol. Survey.)

motion in the daytime, "creeping" over trunks and branches on the lookout for food.

The general color is brown, more or less streaked with lighter colors. It is white below. The length is about five and one-half inches. The ends of tail feathers are stiff and are pressed against the bark of the tree after the manner of woodpeckers. The bill is slightly curved.

Myrtle Warbler or Yellow-Rumped Warbler (Plate 2, Fig. 2).—This common warbler breeds in the northern part of the United States and in Canada. It is found in small flocks among bushes and other low growth.

Its food consists almost entirely of injurious insects. A small part only is represented by fruit and seeds. It is particularly



I. L. WOOD, DEL.

BUR. ENGRAVING, MPLS.

Plate 3. SOME USEFUL BIRDS

7. Yellow-billed Cuckoo. 8. Red-eyed Vireo. 9. Downy Woodpecker. 10. Brown Creeper. 11. Marsh Hawk (Female). 12. Kingbird. 13. Sparrow Hawk. 14. Meadow Lark, larger in proportion than the others.

fond of scale insects and plant lice, and is something of a fly catcher as well.

It is a little over five inches in length. The adult male bird can be easily recognized by the presence of bright yellow patches on the rump, on top of the head, and on each side of the breast. The general colors are grayish with darker stripes; throat, white; more or less black on breast and lower parts. In the young and in the adults, in late fall, the colors are duller, and the characteristic yellow of the crown and rump is either very dim or absent (Fig. 382).

FIG. 382.—Myrtle or yellow-rumped warbler. (After Fuertes.)

It nests in evergreens a few feet above the ground. The eggs are whitish gray, blotched with brown or blue.

The Chestnut-sided Warbler (Plate 4, Fig. 17) is an attractive, insect-eating bird, typical of a large family of warblers. Colors: Crown, yellow; sides of breast, chestnut in male; some greenish yellow in the black of the upper parts; below, white. The length is about five inches. It appears in the northern states about the middle of May.

Maryland Yellow-Throat (Plate 4, Fig. 15).—This beautiful warbler is one of the most attractive of the family. It perhaps is not as useful as many others because of its somewhat shy habits

and the environment of its nest. It is, nevertheless, decidedly insectivorous. Because of this and its beauty it is entitled to our friendship.

The male has a jet-black band across the forehead and over the cheeks. The remainder of the upper parts and tail are olive green. The throat and chest are bright yellow. The nests are frequently on the ground. The eggs are speckled white. This species is found throughout the United States east of the great plains.

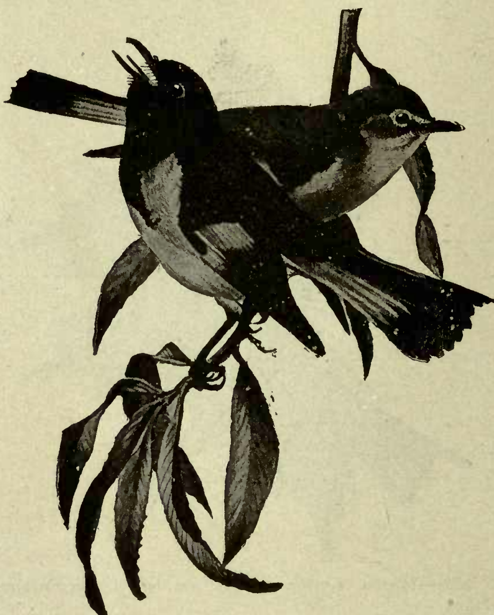


FIG. 383.—American redstart, (1) male, (2) female. (After Fuertes.)

American Redstart.—Fuertes's fine drawing (Fig. 383) well illustrates this beautiful bird. It is one of a large group of wood-warblers, examples of which are given in this chapter. The male is striking because of his activity and brilliancy of coloring. These make him an object to catch the eye of even an indifferent observer. As if conscious of his beauty, he is continually spreading and flirting his tail, extending his wings, and making short flights from the trees, seeking insects, much after the manner of our common fly-catchers. The female is much duller in color, greenish

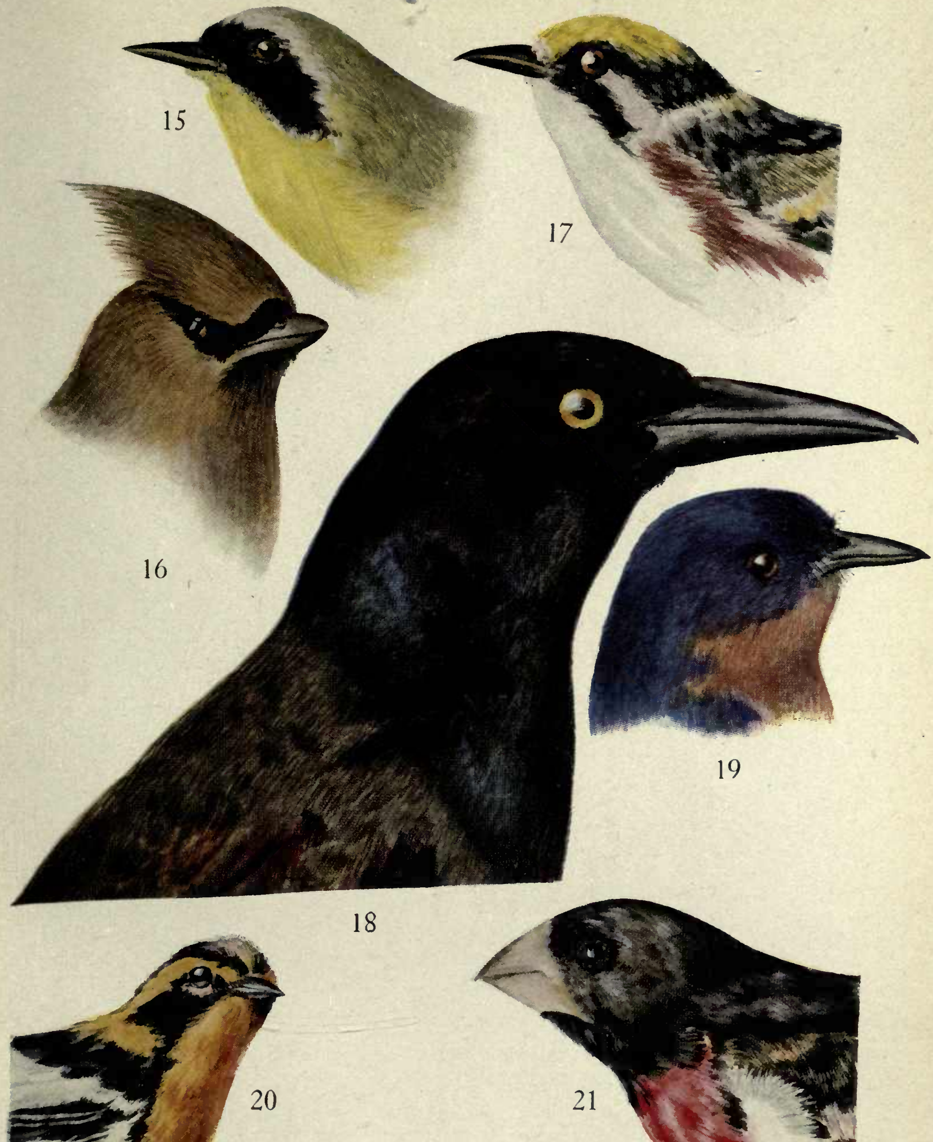


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Plate 4. SOME USEFUL BIRDS

15. Maryland Yellow Throat. 16. Cedar Waxwing, or "Cherry Bird." 17. Chestnut-sided Warbler. 18. Purple Grackle; Crow Blackbird. 19. Bluebird. 20. Blackburnian Warbler. 21. Rose-breasted Grosbeak.

gray on head and back and yellowish where the male is salmon. The colors of male are: Breast, head, and back a deep, lustrous black; long wing-feathers at base a rich salmon; about half of the outer tail feathers, sides of breast, and body beneath wings deep salmon.

The American redstart, like other warblers, is very beneficial because of its insect-eating habits.

Blackburnian Warbler (Plate 4, Fig. 20).—A beautiful representative of the warbler family and a strictly insectivorous bird is here described. Breeding as it does in the evergreen woods, it consumes more insects there than it does in the neighborhood of farms. However, even the warblers that pass through any latitude in spring and again in the fall, not nesting there, are useful, in that they are keen hunters of insects found in our trees at that time. The Blackburnian warbler winters in the tropics.

It is about five and a quarter inches in length. The male is strikingly colored, as indicated in the illustration. The back is streaked with black and white, and the deep orange, shown in the figure, extends over the throat and breast. The under parts are tinged with the same color. It is regarded by many as the most beautiful of all the warblers.

Cedar Waxwing or "Cherry Bird" (Plate 4, Fig. 16).—This beautiful bird is about seven inches long. The tips of the secondary feathers in the wings and frequently the tips of tail feathers resemble red sealing wax; hence the above name. The head and upper parts are a warm grayish brown. There is a conspicuous crest. A jet black line crosses the forehead and through the eyes. A yellow band extends across the tail at its end. The bird is yellowish below.

It is found in varying abundance over the United States and breeds throughout its range. The nest is characteristic, rather bulky, but of loose construction, in which rootlets, moss, twigs and lichens may appear. It is built in fruit trees or in shade trees from six to fifteen or more feet above the ground. The eggs have been described as "putty colored" and irregularly spotted with black or brownish markings. There may be three, four, or five in a nest.

Food Habits.—These birds are fond of canker worms and other caterpillars, and are valuable allies in any orchard. One year in August the writer noted the fly-catching habit of this bird, and the following note-book entry was made: "For almost half an

hour we watched six of these birds, constantly on the wing, hovering over a slough and catching quantities of insects. They seemed never to grow tired, but flew slowly against the wind, deviating now a little to this side, now to that, until they reached the end of the slough. Then back they came to repeat the same maneuver and go over the same ground again and again. Occasionally they uttered the characteristic note of the species, but, for the most part, flew silently. During the time they did not once rest." Only nine out of 152 stomachs of this bird, forty of which were taken in cherry season, contained cultivated cherries.

Red-eyed Vireo (Plate 3, Fig. 8).—Who has not heard and enjoyed the song of this bird emanating from shade trees along a village street on a hot day in summer? It is heard at a time when other birds are silent, and if one sees the songster among the leaves, he will be found to be actively searching for insects, even while giving voice to his song. Over ninety per cent of its food consists of insects.

The nest is pensile in a fork thirty or forty feet above the ground. It is characteristic in its structure, containing strips of vines, bark of trees, and frequently pieces of paper. The eggs, three or four in number, are white, with the larger end sparingly spotted.

The bird is about six and a quarter inches long. The top of the head is gray; and a white line is over the eye, which is red. The remainder of the body is olive colored, except the under parts, which are white.

Northern Shrike or Butcher Bird.—A misconception regarding this bird prevails among many. The mistake is encouraged by its name, and perhaps added to, unfortunately, by the illustrations frequently seen, showing the bird with a captured sparrow. It is true that he kills sparrows and other small birds, a fact evidently fully appreciated by his intended victims, since a panic among them is caused by his appearance. But he atones for this by killing and devouring field mice, shrews, and injurious insects. It is to his credit, also, that he is a persistent enemy of the English sparrow. The latter bird is responsible for many ills; and is now recognized as one means of dispersal of the much dreaded San José scale.

The great northern shrike is common in northern fields until late fall, sometimes as late as December. He is recognized by his peculiar flight, close to the ground, by his size and coloration.

He is about ten and one-fourth inches long; black, gray and white in color, and is at times something of a songster. Among the injurious insects captured might be mentioned grasshoppers and various caterpillars (Fig. 384).

Chipping Sparrow (Plate 2, Fig. 6).—This is one of our most common garden birds. It is unobtrusive, friendly, useful, and welcome; and is easily recognized by its modest, grayish and brownish colors and the chestnut or bay patch on top of the head. Its somewhat monotonous "chipping" note is a common sound in many gardens and dooryards in this country.

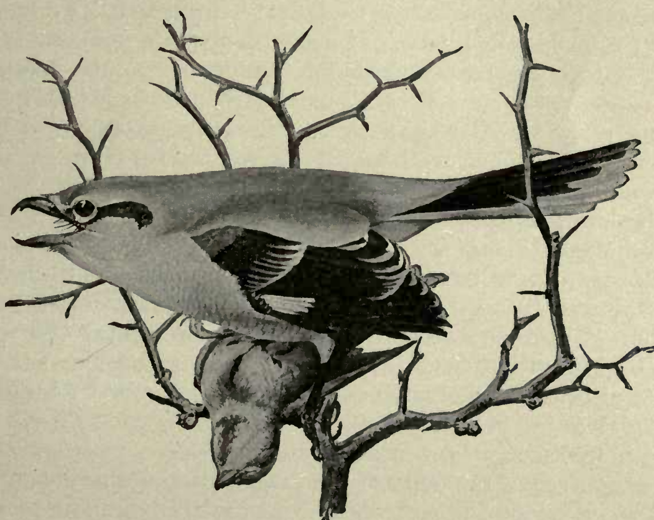

FIG. 384.—Northern shrike or butcher bird with sparrow as prey. (After Fuertes.)

It eats seeds in the fall, but during the summer it helps destroy various insects, including caterpillars, beetles, plant lice, etc. In June it is claimed that ninety-three per cent of its food consists of insects.

The chipping sparrow is a little over five inches long. It nests in trees or vines near houses or in gardens or orchards. The nest is generally lined with horsehair. The four or five eggs are bluish, with blackish or brownish markings.

Rose-breasted Grosbeak (Plate 4, Fig. 21).—This beautiful bird and excellent songster is common in many parts of the United States. The male is at once recognized by the striking black

and white coloration, and by the beautiful rose coloring of the breast and under sides of wings. The female is brownish or olivaceous, the rose on the male's wings being replaced by yellow. As the name indicates, the bill is strikingly large and, even without the above colors, would be sufficient to distinguish this bird from many others.

This grosbeak is about eight inches long. It nests from five to fifteen feet or more from the ground. The four or five eggs are light blue, with irregular brownish markings.

Benefits.—The species migrates to Mexico and is found breeding as far north as southern Canada. Throughout its range it is a help to the agriculturist. It occasionally eats peas and a little fruit, but consumes an enormous number of potato beetles, as well as striped cucumber beetles. It is reputed as attacking scale insects, and the writer has seen it foraging for grasshoppers. Canker worms, tent caterpillars, army worms, cut worms, chinch bugs, and others are known to be included in its dietary.

Cardinal, Red-Bird, or Virginia Cardinal.—This brilliant, crested singer, about eight inches long, is common in parts of the South, as well as resident in the middle states. It sometimes surprises us by being seen in the more northern latitudes. Strangely enough, it has been observed in Iowa and Minnesota in winter. This bird, in places, is known as the cardinal grosbeak. It has the habits of others of the grosbeak group. Two or three broods are produced in the South.

It is frequently seen in cages and makes a contented captive. The bright red of the body of the male contrasts sharply with the deep black about the red bill and on the throat. The female is brownish, inclined to ash, with indications of red, which color is quite pronounced on the crest and on wings and tail.

The Purple Finch.—*Carpodacus purpureus*, and *californicus*, its Pacific coast variety, are worthy of discussion in this treatise. The males have brown coats washed with crimson. They are beautiful singers, but both the eastern and western varieties sometimes cut blossoms from fruit trees, and on the Pacific coast are particularly troublesome in this regard. The writer has seen the ground beneath fruit trees in Oregon strewn with fallen blossoms as the result of this bird's activity. A. R. Woodcock, of Corvallis, Oregon, has this to say of this bird (Ore. Bul. 68):

"Very abundant during March, April, and the early part of May. They sometimes become a nuisance by reason of their

picking the blossoms from the cherry trees and, to some extent, from the plum. The object of these depredations is to secure the young ovary from the blossom. In plucking the latter, it is seized by the calyx tube, wrenched from its pedicle, and cut into in the region of the ovary. The bird sometimes secures the latter organ and sometimes not. Not infrequently trees in Corvallis are fairly stripped by these birds. During the summer and fall they feed upon seeds of wild mustard, rape, cabbage, and asparagus. In winter they may be found around apple orchards, feeding on the seeds of apples which have fallen to the ground and decayed. In the spring they feed extensively on the seed of chickweed. I believe that they destroy enough of the seeds of noxious cruciferæ and other weedy plants to more than make recompense for the damage they do to the fruit trees. They nest in June."

The Scarlet Tanager.—This beautiful bird and excellent songster is found not only in parts of the South, but is fairly common throughout New England and the eastern states, ranging west beyond the Mississippi. The author has found it common in the hemlock woods of Maine, among the deciduous groves of Massachusetts, and in the agricultural portions of Minnesota. Its food is almost entirely insectivorous, and hence it is entitled to recognition as a useful bird. The male is scarlet, with black wings and tail; the female, various shades of yellowish olive.

Meadow Lark (Plate 3, Fig. 14).—The meadow lark is common from the Atlantic to the great plains, and a variety extends westward from the plains to the Pacific coast. It is an inhabitant of both prairie land and fields in districts more or less wooded. While not a fine songster, in the opinion of many it adds much to our enjoyment.

The color of the upper parts is a mingling of black, whitish, and chestnut. It is darker on the head; and a light streak runs back from the bill. The side of the head is light, showing a yellow streak over and in front of the eye. The chin, throat, and breast are bright yellow. A jet-black collar or cravat is on the breast, in the form of a crescent. All but the central tail feathers show considerable white. The length is ten to eleven inches. It nests upon the ground.

Analyses of stomach contents give interesting results: Two hundred and thirty-eight stomachs examined contained seventy-three per cent animal matter and twenty-seven per cent vegetable, the latter being found in the winter. The animal food consisted

of insects of ground species—beetles, bugs, grasshoppers, caterpillars, and a few flies, wasps, and spiders. A number of the stomachs were taken from birds killed when the ground was largely covered with snow, but still contained a large percentage of insects, Crickets and grasshoppers constitute twenty-nine per cent of the entire year's food, and sixty-nine per cent of the food in August. About one-third of the beetles were predaceous ground beetles; the others were all harmful species. In May caterpillars constitute over twenty-eight per cent of the whole food, with a large number of cut worms. Grain makes up fourteen per cent, and weed and other seeds twelve per cent.

The Baltimore Oriole.—This beautiful bird is found in most of the states east of the Rockies, and is, as a rule, a welcome addition to our bird fauna, a flash of orange in the green of a northern summer. However, while it is a favorite on account of its beauty and somewhat pleasing song, its habits are not always of the best from the standpoint of the gardener, and, like the rose-breasted grosbeak, it is fond of peas, and frequently tries the patience of those who are lovers of birds by its depredations in this direction. Methods of protecting the crop are given on page 409. As opposed to its injurious habits, it eats tent caterpillars and other hairy caterpillars, including those of the browntail and gypsy moths, as well as canker worms, cucumber beetles, and grasshoppers. The male is bright orange of various shades and black; the female's colors are duller. Its pensile nest is frequently seen on elm trees.

Bullock's Oriole takes the place of the Baltimore Oriole on the Pacific coast.

The Orchard Oriole is not abundant enough to be of special economic importance to agriculture. It ranges through the eastern United States into the South, and is regarded as a very good singer. The male is black, chestnut below, and the female olive. It is smaller than the Baltimore oriole and with the same general habits. The nest is not so strikingly pensile as is the case with the Baltimore oriole.

The Bobolink.—This favorite of bird lovers is the subject of many a song and poem. It is a common and welcome summer resident in central and northern states. The male fills the fields with drunken melody, while his more modestly colored mate is sitting quietly on her nest, well hidden in grass or clover. So familiar to all is this songster that with figure 385 no verbal description is necessary.

The beauty and song of the male bird are but transient qualities; for after the breeding season he loses his fine clothes, becomes dull olive colored, streaked with black, like the female and young.

Relation to Agriculture.—In the fall these birds fly in flocks southward to wild rice marshes and cultivated rice and grain fields. They go as far as South America for winter. At night one frequently realizes flocks of these birds are passing by hearing their metallic "chink" in the darkened sky above. As "reed birds"

FIG. 385.—Bobolink, male and female. (After Fuertes.)

or "rice birds," they find their way into the markets of the East and South, fattened by voracious feeding in the rice fields. While in the North they eat large numbers of injurious insects.

Red-winged Blackbird.—However injurious the group of blackbirds becomes in late summer and fall, in the spring and early summer they almost or quite pay for their depredations by consuming large numbers of injurious insects. The red-winged blackbird is a welcome arrival in the early spring, as it returns from its winter migration. Its really melodious note is tuneful comfort to

bird lovers, after a winter devoid of feathered singers. The position taken by the bird in uttering its characteristic note or notes discloses to advantage its scarlet shoulders, well set off by glossy black wings, body, and tail (Fig. 386). The grayish-brown female, streaked with black, we may not notice, but the male compels attention.

Food Habits.—The United States Department of Agriculture has made an exhaustive study of this bird's food habits and finds about seven-eighths of its diet consists of harmful insects and weed

Fig. 386.—Red-winged blackbird. (After Fuertes.)

seeds. Locally, when in large flocks, as above intimated, this and other blackbirds may be very harmful. A resort to extreme measures on the part of the farmer is then justified.

Further observations of experts are interesting. For example, in the case of the red-winged blackbird, in 1083 stomachs examined, weed seeds comprised fifty-four per cent of the contents, grain, thirteen per cent, grasshoppers (in August), seventeen per cent, caterpillars, twenty per cent in March, and beetles, ten per cent. In 138 stomachs of the yellow-headed blackbird insects comprised

thirty-three per cent of the stomach contents, weed seeds, twenty-eight per cent, grain, thirty-eight per cent.

Purple Grackle or Crow Blackbird (Plate 4, Fig. 18) eats white grubs, grasshoppers, and other insects, including army worms; but, like other blackbirds, it is capable of doing damage in grain fields when present in large flocks. It is at such times that the farmer is justified in protecting his crops by the judicious use of the shotgun. However, the bird should not be classified as an enemy to the farmer, because it is also known to do much good, as indicated above.

The crow blackbird is twelve inches long. It builds a coarse nest of grass and mud, frequently in evergreens, or even in niches in the cornices of buildings.

King Bird.—This is the policeman of our garden and orchard, bravely attacking large hawks and crows which might be disposed to mischief. It is a typical fly catcher and consumes enormous numbers of insects, thus deserving our protection at all times. It must be admitted that it occasionally attacks honey bees, a goodly proportion of which appear to be drones. Examination of 634 stomachs shows only 61 bees in 22 stomachs; of these, 51 were drones. On the other hand, it devours robber flies which catch and destroy honey bees.

Its length is eight and one-half inches. The upper parts are dark gray. It is almost black on the head, with a concealed flame-colored crest on the head. Its under parts are whitish.

Whippoorwill and Night Hawk.—These two birds are sometimes confused by the uninitiated, but they are perfectly distinct species. The coloring and markings of the two birds also serve to distinguish them. The whippoorwill's colors partake of the browns, while the night hawk is grayish. The tail of the former has the three outer feathers white for about two-thirds of their length. The end of the tail is rounding. The night hawk has a conspicuous white patch on each wing, and its tail is forked. The whippoorwill feeds largely on moths and beetles; the night hawk on May flies, gnats, dragon flies, grasshoppers.

Both are insect-eaters.

The Whippoorwill (Fig. 387) is not often seen, and is not very well known. It is a bird of the woods. Unless disturbed it flies only by night. It is characterized by its peculiar note, oft-repeated: "Whip-poor-will! Whip-poor-will! Whip-poor-will!" with a "cluck" or "chuck" before each call, audible to one close at hand.

This song, quite forceful and penetrating, is heard in the first part of the night and again just before dawn. In coloration the bird harmonizes closely with the wood colors. When flushed, it disappears with absolutely noiseless flight.

The whippoorwill's eggs, two in number, are laid on the ground or on a log or stump in the woods, protected by no nest.

The Night Hawk, on the other hand (Fig. 388), is markedly a bird of the open. It is frequently seen in flight in the afternoon and early in the evening, high in the air, uttering at frequent intervals its rather harsh cry. Occasionally, on half-closed wings, it darts down to the earth with a booming sound, made, it is claimed, by the rush of air through his long wing feathers.

Fig. 387.—Whippoorwill. (After Fuertes.)

The two eggs of the night hawk are laid on the ground or in the fields, or even on a flat rock, with no semblance of a nest. Occasionally they are found on flat roofs of buildings in cities.

The Belted Kingfisher is naturally a lover of wood-bordered streams and ponds. The noisy rattle of this bird is a fit accompaniment to the sound of running water, and it is here that it takes frequent toll of fish which might otherwise have lived to fill the angler's creel. Fish in ponds and streams, therefore, suffer as a result of its rapacious appetite, but its depredations become of marked importance when it habitually takes its food from ponds or streams of those who raise trout on a commercial scale. Frequently the shotgun is used by the fish breeder in defense of his fish. Or, taking advantage of the bird's habit of frequenting a

perch over the water, whence it can see its prey below the surface, a steel trap is placed on the top of an upright pole planted in the pond and the marauder is captured therein.

Its white eggs are placed at the end of a long burrow in some bank near the water. The accompanying virile picture (Fig. 389) by Fuertes, gives an excellent idea of the appearance of this vivacious, noisy, and at times, injurious bird. It should be included under the head of "Birds of doubtful utility."

Yellow-billed Cuckoo (Plate 3, Fig. 7).—The cuckoo is a shy bird. Its back and long tail are a fashionable brown. The under parts are white. The lower half of the bill is yellow, except at

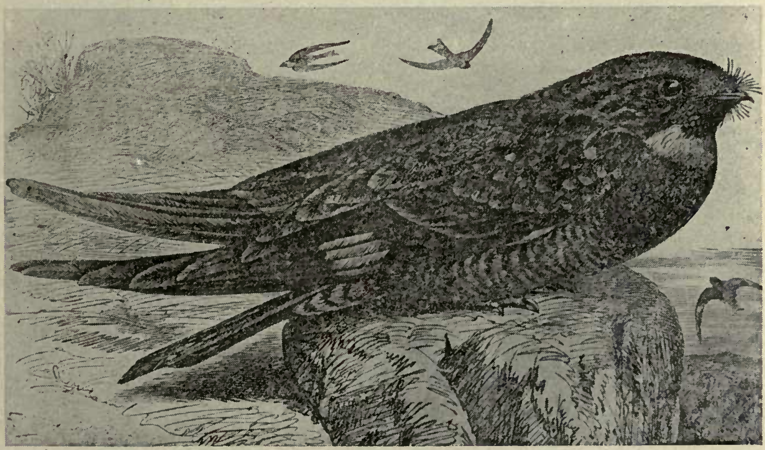

Fig. 388.—Night hawk. (From Brehm.)

the tip. It constructs a loose nest of twigs and lays therein three, four, or five pale green eggs, unmarked. This bird is generally silent, but at times gives utterance to a note repeated in such a way that it sounds like some one calling the cows. Because this is heard sometimes in lowering weather preceding rain, the bird is called by many "rain crow."

It is without doubt one of our most useful birds and one of the few which will eat hairy caterpillars, such as tent caterpillars, and fall web worms. Henshaw (U. S. Farmers' Bul. 513) reports that one stomach which was examined contained two hundred and fifty tent caterpillars; another, two hundred and seventeen fall web worms.

Downy Woodpecker (Plate 3, Fig. 9).—This woodpecker is a true benefactor, in that its food consists almost entirely of injurious insects. It is with us both winter and summer. It is the smallest of our woodpeckers, being only six and four-fifths inches long. It is black above, but has a scarlet band on the back of the neck, and has white on the middle of the back. The under parts are white. The central feathers of the tail are black, the outer ones white, with black markings. The wings are black, spotted

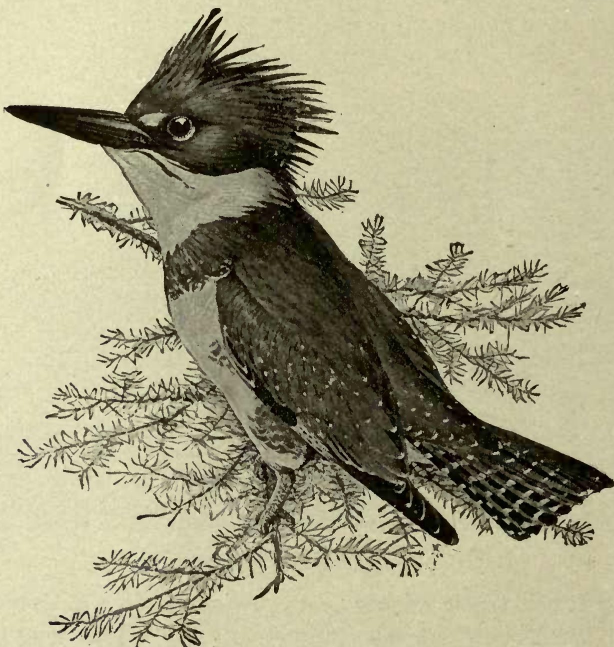

FIG. 389.—Belted kingfisher. (After Fuertes.)

with white. The female lacks the scarlet patch on the back of the neck. It nests in holes in trees.

This bird is often seen in winter in company with nut-hatches, chickadees, and brown creepers. What little vegetable food it eats consists of seeds of poison ivy, sumach and similar shrubs. Seventeen examined specimens had eaten forty insect larvæ, twenty wood-boring grubs, three caterpillars, seven ants, four beetles, a chrysalid, one hundred and ten small bugs, a spider,

a few acorns, small seeds, and a little woody fiber, apparently taken by accident with the grubs. Three-fourths of the food of one hundred and forty specimens examined by the United States Department of Agriculture consisted of insects. Nearly one-fourth consisted of ants, chiefly those which were caring for plant lice or burrowing in wood (Fig. 390, and also Plate 3, Fig. 9).

Fig. 390.—Downy woodpecker.

This common woodpecker, which is one of our most useful birds, is only seven inches in length and has a scarlet band on the back of the head of the male, not in the crown. On account of its size and difference of coloration, it need not be confused with the other species under discussion.

Yellow-bellied Sapsucker.—This is the only bad woodpecker we have, but it has some champions. It preys upon birch, maple,

apple, mountain ash, evergreens, and other trees, sucking the sap, of which it appears to be very fond, and leaving rows of holes about the trunk. Some of the cambium or inner layer of the bark seems to be eaten also. While this bird eats a few insects, the damage it does in causing trees to bleed far outweighs, we believe, the benefits derived from its presence. In striking contrast with

FIG. 391.—Yellow-bellied sapsucker. (After Fuertes.)

other birds whose tongues are adapted for extracting borers from infested trees, the tongue of this species has a somewhat "brush-like" tip. It can not be protruded to any extent, and is thus suited to an entirely different diet from that of other members of the same family. The rows of holes made by this bird upon tree-trunks may result in girdling the tree.

The bird is about eight and one-half inches long. The adult male has crown and throat red, breast black, and belly a shade of yellow. The female has no red on the throat, and the red color of the crown is sometimes replaced by black (Fig. 391).

Hawks and Owls.—Rank injustice has been done this group of birds. We unhesitatingly place the sharp-shinned hawk, Cooper's hawk, and the goshawk as chief marauders against poultry and small birds in the category of bad birds; but a large number of hawks and owls are useful. They prey upon gophers, field mice, rabbits, and other animals inimical to the interests of the forest, the poultryman, orchardist, and gardener. The poultryman, particularly if living near timber, will occasionally lose poultry on account of the presence of hawks, but practically never on account of the three or four birds of prey which we specifically mention as useful.

From time immemorial the farmer's boy has felt justified in shooting every hawk and every owl he meets under the impression that he is doing agriculture a good turn thereby. Whenever he can bring down a crow or shoot into a bunch of blackbirds he feels an honest conviction that his action will be approved at home; hence he returns triumphant. He proudly displays his dead crow or hawk or owl as he walks the village street; while partridge, quail, or "chicken," shot out of season, is packed snugly away under his hunting coat.

Marsh Hawk (Plate 3, Fig. 11).—The male and female are quite different, both in size and color. The adult male is nineteen inches long. It is grayish above, the tail being barred with blackish. The feathers above at the base of the tail (upper tail coverts) are conspicuously white. The breast is gray, fading into white on the belly, where brownish markings are found. The adult female is twenty-two inches long. She is dark brown above, and is marked on the head and neck with reddish brown. The upper tail coverts, as in male, are conspicuously white. The tail is darker brown, barred with reddish brown. The breast is buff; the color fading on the belly. Nests are made on the ground in marshes.

Food.—This is eminently a bird of the meadows and prairies, and is often seen skimming over the top of the marsh grass, hunting its food, at which time the white of the upper tail coverts is conspicuous. It eats field mice, squirrels, rabbits, grasshoppers, frogs, and reptiles. Occasionally small birds or poultry are taken, but not often. The writer regards it as a useful bird to the agriculturist.

Out of one hundred and twenty-four stomachs examined by the United States Department of Agriculture, seven contained poultry or game birds, thirty-four contained other birds, fifty-seven contained mice, twenty-two contained other mammals; seven contained reptiles; two contained frogs; fourteen contained insects, the contents of one were undetermined, and eight were empty.

Fig. 392.—Great horned owl. (After Fuertes.)

Dr. H. B. Warren examined fourteen stomachs with the following results: Seven had only field mice in their stomachs; three, frogs; two, small birds (warblers); one, a few feathers, apparently of a sparrow, and fragments of insects; one, a large number of grasshoppers, with a small quantity of hair, evidently of a young rabbit.

Sparrow Hawk (Plate 3, Fig. 13).—This is our smallest and most beautiful hawk. It is common in fields and along roadsides

in the late summer and fall, at which time it consumes large numbers of grasshoppers. It also eats caterpillars, other insects, and spiders. At least one-fourth of its food consists of field mice, shrews, and field-dwelling house mice. It occasionally preys upon young birds, but this is not a common trait of this species. A Biological Survey bulletin states: "Out of four hundred and ten stomachs examined, three hundred and fourteen were found to

Fig. 393.—Virginia quail or bob white. (After Fuertes.)

contain insects, one hundred and twenty-nine, small mammals, and seventy, small birds." We unhesitatingly class this species with our useful birds. It is found throughout the United States, breeding wherever it is a summer resident.

It is about ten inches long. The back of the male is brownish red or rufous, with black bars. The tail is rufous, with a black band near the end; the extreme end is white. The head is bluish, with brown shadings. The under parts are spotted with black.

A hole in a tree is utilized as a nest. The eggs are whitish or creamy, three to seven in number.

Great Horned Owl.—This striking bird, reaching the northern states sometimes as early as February, is quite common in wooded sections. Rabbits, gophers, muskrats, field mice, and other night-prowling animals represent a large share of the diet of this bird. Poultry, too, are attacked if farmers allow their turkeys and chickens to roost in tops of trees, on sheds, or other exposed places. Even skunks (Fig. 392) are highly prized by them for food. In fact, when caught, they are frequently scented with skunk odor. With the exception of the skunk, which is ordinarily a useful citizen, the other mammals mentioned must be regarded as injurious—most of them decidedly so. Hence this owl is, to a large degree, a benefactor.

Fig. 394.—Mourning dove. (After Fuertes.)

The Virginia Quail or Bob White is holding its own fairly well in many northern states in spite of severe winters, and is pushing its way farther north when conditions are favorable. This bird is such a good friend of the agriculturist that it deserves protection. Its fine qualities as a table bird make it an object of pursuit on the part of hunters. Potato bugs and even chinch bugs have been found in its crop, and grasshoppers, as well as many other varieties of injurious insects, compose a large proportion of its bill of fare (Fig. 393).

The Mourning Dove.—This dove is common in middle and northern states. It was at one time included in our list of game birds, with a regular open season. It is now appreciated as a somewhat useful or at least a harmless bird (Fig. 394). U. S. Farmers' Bulletin 513 reports the finding in one stomach of 7500 seeds of yellow wood sorrel. In another were found 6400 seeds of foxtail. In a third there were 2600 seeds of slender paspalum, 4820 seeds of orange hawkweed, 950 of hairy vervain, 120 of Carolina cranesbill, 56 of yellow wood sorrel, 620 of panic grass, and 40 miscellaneous weed seeds.

The Golden Plover was formerly abundant in the United States, but it is now a rare bird. It is occasionally seen in some of the northern states during the migrations (Fig. 395). At such times its food consists chiefly of grasshoppers and other insects. It is included here as representing a group useful to the agriculturist. Another example is the field or upland plover, which is also a vanishing bird.

The Barn Swallow (Fig. 396), which captures, while on the wing, moths, flies, beetles, and grasshoppers, is a charming addition to any farm scene. House bed-bugs, contrary to a very common belief, are not found in swallows' nests.

The Purple Martin is an excellent addition to any farm. It should be provided with a martin house and its presence encour-

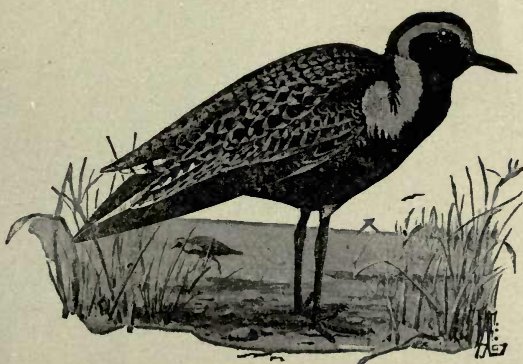

Fig. 395.—Golden plover. (After Fuertes.)

aged. This bird wages relentless war upon hawks and crows, and constitutes, therefore, a guard for poultry and small birds.

The Song Sparrow, so dear to us all, deserves a prominent place on our list. It is not only friendly and attractive because of its song, and from the fact that it is one of the earliest bird arrivals from the South, but it consumes a large amount of weed seeds and many insects.

The Yellow Hammer, Flicker, or Golden-winged Woodpecker (Fig. 397), while a useful bird, is not as useful as many other woodpeckers. It obtains a share of its food from the ground. That is, it is very fond of ants and is quite likely to be discovered dining on them upon the lawn. It eats wood-boring grubs to some extent, but is not as industrious in that direction as many

of our other woodpeckers. It occasionally takes a little fruit, and is reported to eat grain, though very rarely. On the whole, it is a useful bird, and we are attached to it because we associate its characteristic call with the promising days of early spring, before the leaves appear on the trees.

The Black Tern is found abundantly about prairie sloughs in

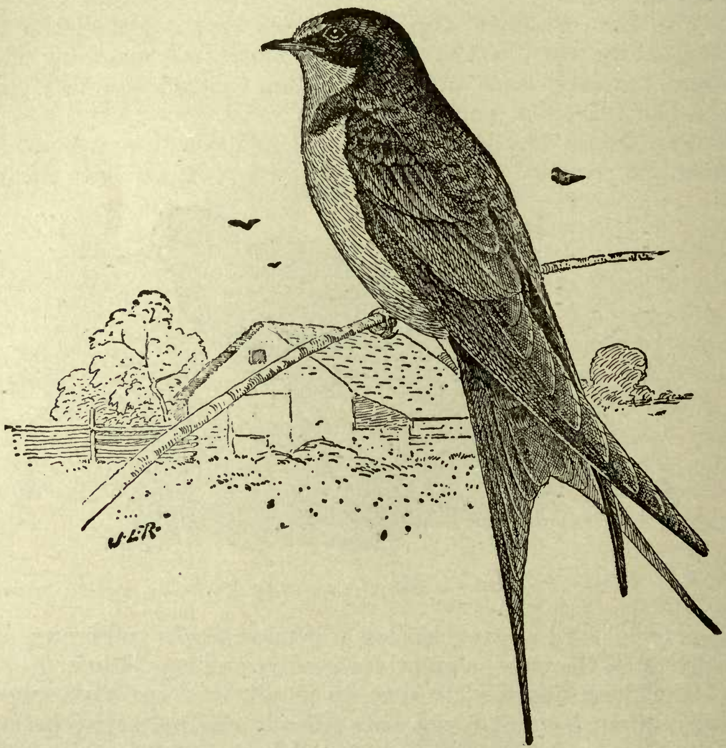

FIG. 396.—Barn swallow. (U. S. Biol. Survey.)

the West. It is perhaps the most representative of the group in the upper Mississippi Valley. The tern is a good friend of the farmer, for when the sloughs are dry, and even before, they consume large numbers of grasshoppers. We illustrate the common tern in figure 398.

Franklin's Rosy Gull is a bird found in prairie sections of the West. It is a voracious eater of grasshoppers.

Birds of Doubtful Utility.—We have already mentioned the cat-bird, whose usefulness is sometimes questioned. The crow and various blackbirds are placed here, for they will, at times, call for radical treatment. We have seen both crows and blackbirds hunting grasshoppers in the stubble fields, and both are known to eat other insects. But their food habits are such as to make their constant protection undesirable. When necessary, the farmer should not hesitate to resort to extreme measures to protect his crop. Crows, it should be noted, are fond of field mice.

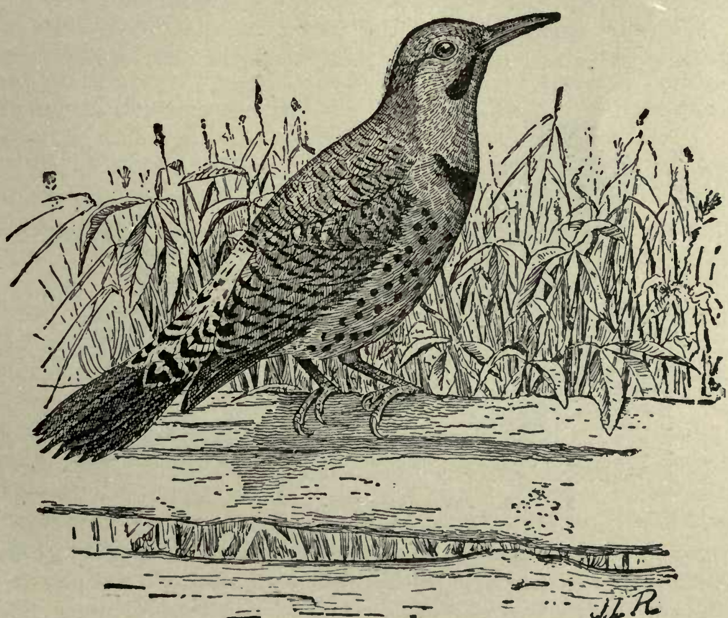

FIG. 397.—Flicker, golden-winged woodpecker, or yellow-hammer. (U. S. Biol. Survey.)

Like the crow, our bluejay sometimes robs birds' nests of both eggs and young birds. However, since he is something of an insect eater and only occasionally resorts to corn or other grain, it would be hardly just to make war upon him. The belted kingfisher, as before intimated, certainly belongs in the category of birds of doubtful utility.

The European Sparrow is a great nuisance, as we all know. From the farmer's standpoint, he is an undesirable citizen in every

way. Some Englishmen have objected to this bird being referred to as "English sparrow"; hence the above more correct appellation. This introduced pest probably can not be exterminated, but its numbers about a dwelling, and even in towns, may be materially lessened.

Trapping.—A wire "sparrow trap" now on the market is used with some success, occasionally catching ten or eleven birds in one morning. They finally learn to avoid this trap, and consequently its location has to be changed. Young birds, as one would expect, are more susceptible to trapping than old birds.

Shooting.—Coöperation on the part of the neighbors in shooting these birds and destroying their nests, in one locality, met

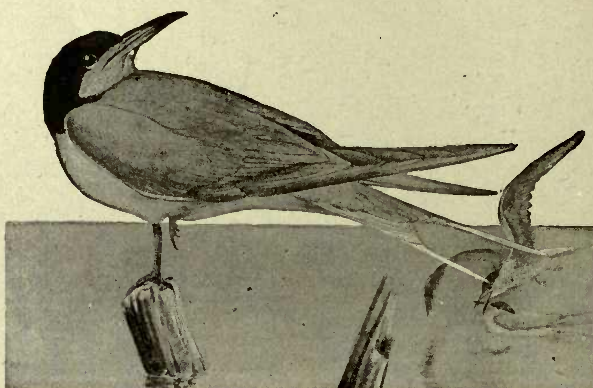

FIG. 398.—The common tern. (After Fuertes.)

with such success that an offer of fifty dollars by a citizen for a specimen captured or shot within the city limits was not claimed. Repeated destruction of their nests and shooting them as they seek the cornices of a dwelling for roosting eventually cause them to leave.

In the country, where one can use a shotgun, these birds may be "baited" in winter by feeding wheat placed on the ground in a line for several mornings; then rake the feeding birds with a charge of shot.

Poisoning.—Poisoned wheat or cornmeal can be used. A little powdered strychnine is added to the grain in a shallow box. Put the box on the end of a pole five or six feet from the ground. This will prevent poultry from being poisoned. It is worthy of

note that several sparrows so poisoned have been fed to a house cat with no bad results.

The above recommendations may appear rather harsh to bird lovers, yet the writer, in common with many others, is so convinced that the presence of this sparrow is a menace to other birds that he does not hesitate to urge its destruction.

How to Study Birds.—For one disposed to make a study of birds, a few reliable and helpful books, referred to at the end of this chapter, a pair of inexpensive field glasses, a note-book, and a love of field and wood to invite to the haunts of birds, are all that is necessary. A camera, if one should have the time and inclination toward that phase of the work, will add to the interest. Observation sheets may be obtained from the Bureau of Biological Survey at Washington; and this bureau is always glad to receive notes on bird migration and kindred phenomena.

The writer, as a result of several years' observation, constructed a table for reference, something as follows: Twelve spaces, separated from each other by heavy lines, are made on cards of suitable size for the pocket. These spaces represent the months. An additional wider space is ruled on the left for birds' names. Opposite the name of each bird studied is entered a mark denoting whether the bird was common, fairly common, rare, or a summer resident, a permanent resident, or an occasional visitor. A line is drawn through the month spaces so as to show the date of its arrival and departure. For instance, opposite the name of robin appeared a long, heavy dash running from the latter part of the space devoted to March, through the space devoted to the intervening months, and into November far enough to indicate approximately the date of departure of the robins. A bird which is rare would have a lineal mark of some sort, possibly a broken line. Bird clubs, such as the national and state Audubon societies, print forms suitable for bird notes.

These cards or notes may be inclosed in a leather-covered case and carried in the pocket, forming a ready reference for use on the field trips. On starting into the field with a card previously made, one could tell at a glance what birds might be found. New and unrecorded observations would occasionally call for changes on cards.

Observations should be made of a number of things: (1) Food habits during the nesting season. (2) Food at other times. (3) When nesting begins. (4) Kind and location of nests. (5) Dates

of nesting, incubation, brooding. (6) Season of flocking, if at all. (7) Songs at different seasons. (8) Enemies and tragedies. (9) Habits of flight. (10) Migration. (11) Variations in color due to age and season. (12) Differences in marking due to sex. (13) Bird census for different kinds in the community. (14) Habits with reference to proximity of water. (15) Other points.

How to Attract Birds.—Allowing that birds deserve our protection, one naturally asks, What can we do to draw them about us? Trees and shrubbery, of course, attract them. U. S. Farmers' Bulletin 621 gives a list of about eighty trees or shrubs whose fruit affords food to birds. Some of these should be on every one's grounds.

The establishment of bird refuges and game preserves is doing much to conserve bird life.

The artistic bird houses now on the market are a help in this direction. These are constructed not only for bluebirds, wrens, and martins, but also for nut-hatches, woodpeckers, and other species. An ingenious boy or man can easily construct houses which answer the requirements very well and at but little expense.

Bird Houses.—In passing, it may be well to state a few very necessary facts about bird houses known to many, but not all. Wren houses should be free from the preceding year's litter before one can expect them to attract newcomers. If the entrance to a wren house is the size of a silver quarter, it will admit the wren but keep out the European or English sparrow. Martin houses should be placed on high poles or in conspicuous places where the martins can see them, not too near to trees. A weather-worn martin house is apparently more attractive to these birds than a newly painted domicile.

The Brush Hill Bird Club, of Milton, Mass., has published the following directions relative to the construction of bird houses:

"*Bluebirds and Tree Swallow.*—Box, 12 × 6 × 5 inches; size of hole, 1½ inches; height from ground, 8 to 30 feet.

"*Wrens and Chickadees.*—Box, 12 × 5 × 4 inches; size of hole, 1¼ inches; height, 6 to 25 feet.

"*Flickers.*—Box, 15 × 10 × 8 inches; hole, 3 to 3½ inches; height, 6 to 25 feet.

"*Screech Owl.*—Box, 15 × 12 × 12 inches; hole, 3 to 3½ inches; height, 15 feet.

"*Martin House Colony.*—Holes, 2 inches; pole, 16 to 20 feet high in open spot where martins can easily see it.

"*The Boxes.*—The cover should be detachable, so that the box can be cleaned easily.

"A sloping top with an overhang is a protection to the young birds from both sun and rain.

"Squirrels may be kept out of the boxes by putting a piece of zinc around the hole so that they cannot enlarge it by gnawing.

"The box should be ventilated.

"Poles are preferable to trees for erecting houses, as they afford protection from both cats and squirrels.

"Wood is the best material. Tin or earthen boxes should be placed in the shade."

Put a six-inch shelf of zinc around the pole to help keep off cats and squirrels.

Feeding Birds.—In summer birds generally obtain enough food without special help from man, but in winter, when the natural food is scarce or covered with snow, any provision in this direction which we may offer is appreciated. Shrubs, some of which have fruit on their branches all winter, have been referred to before. In addition, one may give them suet, or meat, or grain. Receptacles may be constructed or purchased to hold these somewhat differing foods and protect them from the weather. The writer has tacked lumps of suet to tree trunks with nails and has been gratified, in snowy weather, at seeing numbers of chickadees, nut-hatches, brown creepers, downy woodpeckers, and bluejays avail themselves of food thus offered. There is a better way of feeding suet by enclosing it in a wire basket and thus avoiding waste.

Crops Attacked by Birds.—Since man, in clearing and cultivating the land, has removed much of the natural vegetable food of birds, and has frequently replaced it with equally appetizing domestic fruit and vegetables, it is very natural that the birds should turn to the cultivated fruit apparently placed within reach for their special benefit. The protection of crops from the attack of birds, therefore, becomes at times a serious problem to the gardener or orchardist or farmer, who, appreciating the services rendered earlier in the season, is loath to kill the innocent marauders, or, even if so disposed, is restrained by law.

Protection of Garden Truck.—It tries even a bird lover's patience to see garden peas over which he has spent time and labor disappear before his eyes as fast as the pods fill. In the writer's experience, orioles have been the chief malefactors in this

connection, though later the rose-breasted grosbeak developed a fondness for this vegetable. English sparrows often eat peas, lettuce, and other garden crops. A scarecrow erected near the rows does little or no good. But cheap white mosquito bar over the plants will prove effective. It is a little expensive and possibly has no particularly good effect upon the growth and development of the pods. This netting can be pegged down on either side of the rows so as to completely exclude the birds. In the writer's garden this was not done on every row, but it was found that orioles once caught under the netting became so terrified that when finally released, did not again trouble the plants.

A friend has suggested the following, much in use in South Africa, where some protection against birds is absolutely necessary: Two stakes are driven into the ground at each end of the row—that is, a stake at each "corner"; then ordinary cheap black cotton thread is run from stake to stake as high as, or higher than, the plants, and close enough together to make it impossible for the birds to fly to the plants without striking one or more strands. Apparently this thread is not seen by them, and contact with it causes some terror. If the row is a long one, additional posts are called for.

Netting of mosquito bar is frequently resorted to in protecting strawberries, currants, cherries, grapes, and other fruits. Some birds are intimidated by white strings or rags or bright pieces of tin or paper bags swaying in the breeze. But this is seldom true of the orioles with a fondness for peas. Other means of saving products of the garden will no doubt suggest themselves to the gardener.

Protection of Field Crops from Birds and Other Animals.—Corn, after being planted, is subject to the attacks of a few animals which cause loss to the farmer. Chief among these at times is the crow. Any treatment given the seed to protect it from the attacks of this bird will, at the same time, afford protection against a few insects which occasionally eat the seed, and also reduce the loss from striped squirrels, gophers, and kindred four-footed creatures.

Poisoning.—Crows can be poisoned by dissolving ten cents worth of sulfate of strychnine in enough hot water to soak up two quarts of corn. This should be scattered late in the evening about the field where crows are working so they may find it there in the early morning. One should not forget that strychnine is a deadly poison.

Tarring Seed.—One of the safest and best ways of tarring corn and yet not affecting its use in a planter is one originating in Massachusetts. "Put one-fourth to one-half bushel of corn in a half-barrel tub; pour in a pailful of hot water, or as much as is necessary to well cover the corn; dip a stick in gas tar and stir this briskly in the corn; repeat until the corn is entirely black; pour off on burlap sacks; spread in the sun and stir two or three times during the day. If this work is done in the morning and the day is sunny, the corn will be ready for the planter the next day without any other care." A machine will easily handle corn treated in this way. Another way is as follows: "Put corn in a fertilizer sack; pour thinned tar on the corn; tie the sack; let the boys tumble the sack about; add ashes or land plaster; tumble some more and it is ready for the planter." The gas tar may be diluted with linseed oil or gasoline.

Scarecrows.—If scarecrows are used, they should be changed occasionally. Forbes, in "Useful Birds and Their Protection," advises the use of a barrel hung on a leaning pole.

It has been found that white twine about the edges of a corn field, strung on high poles, and hung with strips of tin and white rags, one about every thirty feet, is fairly effective in keeping crows away from a planted field. If, in addition to this, a few dead crows are suspended from high poles in different parts of the field, the combination of white twine and bright tin shining in the sun and the dead crows as a warning to would-be evil doers works so well that the farmer may rest assured it will be many days before his field is touched by these marauders. This remedy, or the twine alone, is in quite general use to-day.

Shooting.—If one is a good shot with a rifle, and can "pick off" a crow or two at long range, the birds keep away from a field so protected. Even if not hit, they seem to realize that it is dangerous ground. Any birds killed should be hung up in the field.

QUESTIONS

1. Enumerate the relations of birds to agriculture.
2. What is the scientific name of the class, and the names of two leading orders?
3. Name ten families of birds in the Order Passeres that are important from the standpoint of the agriculturist and orchardist.
4. Give in detail the habits, good or bad, of the following: Robin, wood warbler, kingbird, wren, blackbird, chickadee, downy woodpecker.

5. Give some arguments for and against the protection of crows; yellow-bellied woodpecker.
6. What determines the usefulness or contrary of any bird?
7. Why should a farmer hesitate before condemning any bird?
8. Name some beneficial hawks; some injurious ones.
9. Suggest methods by which birds may be attracted.
10. Give details necessary in construction and use of bird houses.
11. Enumerate some of the methods for protecting crops from small birds and from crows.
12. Give the bad, and good qualities (if any) of the English or European sparrow.
13. What can you say from your own experience in its favor?
14. What methods are suggested for its destruction?
15. From your own observations, would you regard the brown thrush to be useful or the contrary? Give reasons.
16. How would you judge the cat-bird in this connection?
17. Give points to be observed in the study of birds.

References.—U. S. Farmers' Bulletin: 493, The English Sparrow as a Pest; 497, Game, Aquatic, and Rapacious Birds in Relation to Man; 513, Fifty Common Birds (15 cents); 609, Bird Houses and How to Build Them; 630, Some Common Birds Useful to the Farmer; 755, Common Birds of Southeastern United States.

U. S. Dept. Agr. Yearbook Separates: 504, Plants Useful to Attract Birds and Protect Fruit; 659, Winter Crow Roosts. Leaflets and Bulletins, National Association of Audubon Societies, New York City. Bird Guide to Land Birds, C. K. Reed, Worcester, Mass.

CHAPTER XXI

SOME FOUR-FOOTED PESTS OF THE FARM

FARMERS and orchardists suffer serious losses from rodents. The various species of rabbits, field mice, ground squirrels, gophers and prairie dogs levy an annual toll of over ten million dollars upon agricultural products. In wooded sections of the middle and northern states the cottontail rabbit works havoc in winter in nurseries and young orchards, frequently girdling valuable trees. Rats are destructive to corn, grain, and other stored products, and also endanger life by spreading disease.

The injuries of a number of the most common animals of this character are discussed in this chapter, and practical remedies are given.

Hares and Rabbits.—It is hard to draw a sharp line between hares and rabbits. The names are applied indiscriminately to almost all animals of this group except the cottontail. In general, it may be said that the true hare does not burrow, but it would hardly be correct to say that all members of this family which do not burrow are hares. The so-called Belgian hare is not a hare, but a rabbit. This animal burrows if allowed to do so, plucks fur from itself to prepare its nest for its young, and gives birth to a litter of from four to eight or more whose eyes are closed at birth. In marked contrast, the prairie hare, commonly called the jack-rabbit, crouches on its form upon the prairie and produces from one to six young, whose eyes are open when born. The development of the young jack-rabbit is very rapid, and when it is only a week old it is nearly or quite able to look out for itself.

The cottontail or gray rabbit (Fig. 399) is found over almost all of North America. On account of its wide distribution and the rapidity with which it increases, it is the most injurious of the rabbits. While the cottontail resorts to burrows made by other animals, when they are available, it may have a brush heap, or even a tussock of coarse grass or weeds, for its home. It breeds in early spring and on through the season. On an average, from two to four young (Fig. 400) are produced at a birth, and there may be more than one litter. The young are weaned when about three weeks old. There is good authority for the statement that

members of this species may bear one or possibly two litters before they are a year old.

Injurious Work of Rabbits.—Clover and alfalfa are favorite foods, as are many of our garden vegetables and fruits, and the writer has discovered to his cost that the cottontail will eat the tender tips of growing tulips. Gray rabbits are most destructive in the winter, eating the bark of orchard trees and nursery stock, frequently biting off the trees in a nursery with a cut as smooth as that of a knife, and in the same way pruning uncovered grapevines and ornamental shrubs.

Fig. 399.—A cottontail rabbit.

The natural enemies of rabbits include almost all of our larger hawks, the marsh owls, and the great-horned owl. Crows sometimes kill young rabbits. Weasels, foxes, prairie wolves or coyotes, and probably minks and skunks, also prey upon them.

The relentless warfare continually waged against hawks and owls, foxes, coyotes, and skunks is, in a large measure, responsible for the prevalence of rabbits and field mice in numbers great enough to do serious injury.

Rabbits are intermediate hosts for internal parasites of the fox and coyote. In summer time the presence of one or more of these is unpleasantly evident, and bots and ticks are also found upon them in the warm weather. In winter, rabbits are of some value as food for man.

Poisoning rabbits in spring, before green food is obtainable and before the first litter has been produced, is a good plan for eliminating the cottontail. Poisoning late in the fall or during winter is also recommended. Coöperation on the part of neighbors in this matter is desirable.

The method of procedure is as follows: Powder some crystals of sulfate of strychnia with the head of a heavy nail, without removing the strychnine from the small bottle in which it is sold. Put as much of the powder as can be held on the point of a pocket-

Fig. 400.—A nest of young rabbits. (Ohio Station.)

knife into slits in small pieces of apple. These pieces may be stuck on small twigs and set in the snow in order that they may be easily seen above the surface. One can not be too careful with poisons of this sort. These poisoned baits should be distributed in such a way that other animals and children can not get at them. Parsnips or carrots or melon rind may be substituted for the apple, and frequently a change of bait is desirable. When using poisoned fruit or roots, other fruit and roots should be kept out of reach of the animals to be killed.

Young and freshly cut apple twigs or suckers bearing buds may also be used, dipping them in a sweetened strychnine solution

and placing them about orchard or nursery or in rabbit runways elsewhere. Be sure that the buds are poisoned. This method is applicable in winter or spring, and has an advantage over the first-mentioned method in that it does not endanger the lives of birds and other valuable animals.

Rabbits killed by poisoning should be collected and buried or burned, so that the poisoned carcasses may do no harm. The strychnine itself should be carefully guarded and kept out of reach of children.

Repellent washes against rabbits, upon tree trunks and shrubbery, are strongly recommended in order to prevent the ravages of the cottontail. One application may be made in the fall and perhaps another on a warm day in winter or in early spring. A heavy whitewash, made a deep blue by the addition of bluestone solution, is excellent. Washes should not be allowed to freeze, and therefore should not be applied in severe weather.

A poison wash for the trunks of young trees, used effectively in Idaho against jack-rabbits, is recommended. The recipe for making it is as follows: Dissolve one ounce of strychnia sulfate in three quarts of boiling water. Dissolve one-half pound of laundry starch in one pint of cold water, stirring thoroughly. Pour the starch into the vessel containing the strychnine and boil the mixture a short time until the starch is clear. Add six ounces of glycerine and stir. When the paste is cool enough, apply to tree trunks with a paint brush.

Certain colloid substances are on the market which promise to afford good vehicles for strychnia, and which will last on trunk and branches for a long period.

Shooting and Driving Jack-Rabbits.—Jack-rabbits are also killed by shooting from wagons or automobiles. Rabbit drives are of common occurrence in the West, a large number of neighbors, mounted or in wagons, coöperating. The animals, sometimes thousands in number, are forced into a corral and killed.

Rabbit Guards.—Mechanical guards of various kinds are also used to keep off rabbits. These may be of paper, but tarred paper will sometimes kill young trees. We may use wire screen (Fig. 401) or wood veneer (Fig. 402). The writer has successfully used several thicknesses of newspaper, tied securely about the trunk. Heavy building paper or cornstalks used in the same way are efficacious. All of these guards should extend a few inches into the ground, in order to form a barrier against mice, and should

reach two feet or more above the ground. The guards may be removed in summer, when danger from rabbits and mice is over. But they are frequently left on to protect the trunks of the young trees from sun-scald and from borers. Ornamental shrubs may be drawn together in the late fall and wrapped with old canvas, burlap, or heavy paper.

Trees and shrubs should be protected by mechanical guards or washes, even if poison is used.

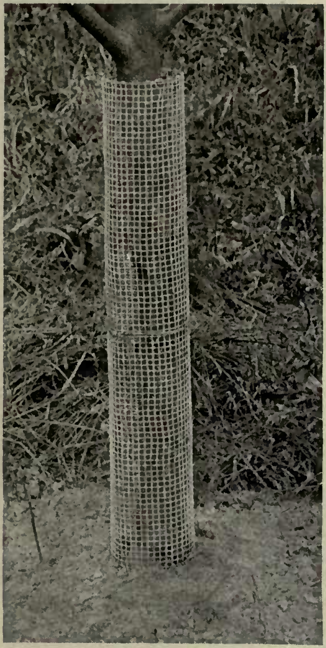

FIG. 401.—Apple tree protected by wire screen. (Ohio Station.)

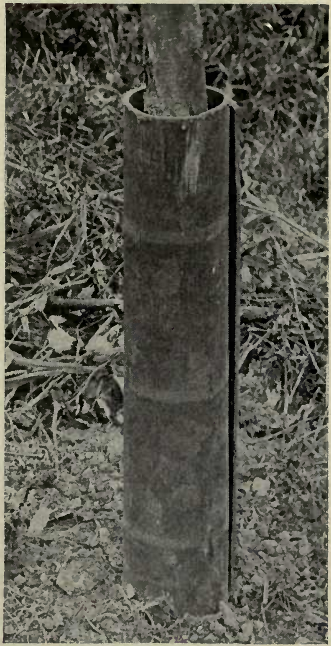

FIG. 402.—Tree guard made of wood veneer. (Ohio Station.)

Trapping rabbits, as every boy knows, can always be resorted to. The cottontail readily falls victim to the old-fashioned box trap and to snares of various kinds.

Fencing Against Rabbits.—The so-called "rabbit-proof fences" may be efficacious in summer, if properly installed. They afford sufficient protection for melons and similar crops. But, unless they are quite high, they may occasionally prove useless in winter, when drifted snow provides a way over.

Girdled Trees.—Many a valuable tree, girdled by rabbits or mice, has been saved by bridge-grafting (Fig. 403)—a process easily understood by any one who has done any grafting. It consists in using long scions to "bridge" the portion deprived of

FIG. 403.—A tree "bridge-grafted." (Ohio Station.) Note: the scions should be closer to the tree.

its bark. The cambium or inner bark of the scion is made to come in contact with the inner bark of the tree, both above and below the injury. Grafting wax is used to protect the ends of the grafts from the weather. Three, four, or more grafts are used on each tree.

Frequently a girdled tree will produce leaves the first summer after the injury, but it will die before the next season, if completely girdled.

Pocket Gophers.—Pouched rats or pocket gophers are serious pests in some parts of the country. These animals (Fig. 404) are provided with a pocket-like pouch on each side of the head (Fig. 405). The pouches are outside, independent of the mouth. The presence of mounds of earth in garden, orchard, or lawn indicates the presence of either a pocket gopher or a mole. The burrow of the gopher is sometimes left open temporarily, which is not the case with that of the mole.

The first litter of the pocket gopher is born in the spring, late in April or in May, in northern states. The litters average one or

Fig. 404.—A pocket gopher. (After Merriam, U. S. D. A.)

two. There is probably only one litter a year. Evidently only one pocket gopher occupies a burrow, except during the breeding season. Pocket gophers are largely nocturnal in their habits above ground.

Hawks and owls, foxes, weasels, and the common house cat prey upon pocket gophers. It is probable that the larger snakes also devour them.

Trapping Gophers.—A small steel trap may be set in the burrow by digging down a foot or more behind a newly made mound. The top of the trap should be on a level with the floor of the burrow and nearly covered with fine earth. The opening should be covered in order to exclude the light.

A Gopher Gun (Fig. 406) has been used by the writer against

both pocket gophers and moles. There is some danger in handling it, and it is not, therefore, recommended for general use.

Poisoning Gophers.—By far the best way to destroy pocket gophers is by poisoned bait. This is used in the spring, before root crops are in the ground and before an abundance of green food is available, and particularly before the young are weaned. As much powdered strychnine as can be held on the point of a knife blade is introduced into a slit in a small piece of parsnip, carrot, apple, or potato, or a large raisin. The bait is placed, by means of a spoon tied to a stick, deep down in a branch burrow or, better, in the main runway, reached through the branch burrow. It may be opened if necessary. This is very effective. It is well to place a few drops of anise on all poisoned bait for rodents. In poisoning pocket gophers or prairie dogs, mounds should be levelled down after placing the poison, and thus one may know, by looking for new mounds, whether the animals have been killed or not.

FIG. 405.—Outline of head of pocket gopher showing extent and opening A of cheek pouch on left side.

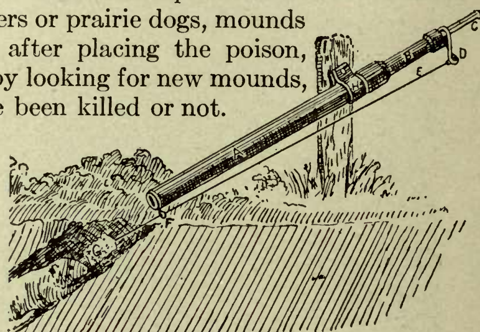

FIG. 406.—An effective but unsafe gopher gun made with a piece of gaspipe.

Fumigation with bisulfid of carbon is not satisfactory.

As is generally well known, the main burrow of these animals is from twelve to eighteen inches below the surface, and the mounds we see upon the surface consist of the excavated earth, pushed by the gopher to the openings of the lateral burrows leading from the main burrow (Fig. 407). The pockets or cheek pouches are used to carry food, not earth.

The appearance of mounds of the pocket gopher in an orchard, young or old, should be the signal for the owner to immediately take steps to destroy the unwelcome visitor, even if no injury due to its presence is evident at the time.

Ditches for Gophers.—Dig a ditch the width of a spade and sixteen inches deep around the field or orchard to be protected.

At intervals of about forty yards in this ditch sink five-gallon oil cans, their tops just reaching the bottom of the ditch and occupying its entire width. Gophers falling into the ditch and seeking exits fall into the cans. In California and other dry regions such ditches should be made in June, before the natural growth dries up, and before gophers begin to seek cultivated crops. This form of trap will also catch some field mice.

The Striped Gopher.—The "thirteen-lined gopher" or ground squirrel (Fig. 408) feeds upon insects in all stages. Vegetable food, however, such as seeds, buds, grain, and clover, forms the larger part of its food. Sometimes, as intimated above, these animals become decidedly destructive. They yield readily to poisoned grain placed in their burrows; they can be snared with a slip-noose, and their numbers may also be kept down by means of a gun.

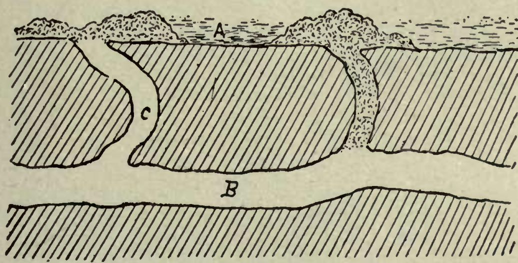

Fig. 407.—Diagram of burrow of pocket gopher; *A*, surface of ground; *B*, main burrow; *C*, branch burrow open.

The "thirteen-lined gopher" mates in early spring. The young are born early in June in the North. The number in the litter varies from one to twelve, but the average is five or six. The young are without hair until about three weeks after birth.

The natural enemies of this timid animal are foxes, weasels, hawks, skunks, the common house cat, and probably the larger snakes. This so-called "gopher" is really a ground squirrel, and belongs to the genus *Citellus*.

Ground Squirrels, Digger Squirrels, Gray Gophers.—In the Middle West and on the Pacific coast these pests (Figs. 409 and 410) are commonly injurious to grain, cutting off stalks, feeding on the juicy parts and frequently upon the grain itself. Perhaps the chief injury is caused by their mowing down the grain. Barley is preferred, but all grain suffers, as well as timothy, alfalfa, potatoes, and vegetables in gardens.

Early in the spring a litter of six, seven, or more young is

produced. There are evidently two litters. During the winter these animals hibernate, emerging lean and hungry from their burrows in the spring.

Control Measures Against Ground Squirrels.—Poisoning is most effective, and of all the poisons sulfate of strychnia dissolved in water is the one most often recommended. For evident reasons, the best time to poison these animals is in early spring, before the first litter of young is produced. Various recipes for preparing the poison are published. The following one gives good results:

Dissolve one and one-half ounces of sulfate of strychnia in two quarts of water, adding a quantity of molasses, syrup, or

Fig. 408.—Thirteen-lined ground squirrel, or "striped gopher," *Citellus tridecim-lineatus.*

sugar and about one tablespoonful of oil of anise. This last is not absolutely necessary, but makes the bait more attractive. While this solution is hot, mix it thoroughly with one bushel of wheat and let it stand over night. Place the grain in the squirrel's burrow. This is best done in the morning. Use a tablespoonful for each hole. A bushel of this poisoned grain is sufficient for at least one thousand holes. Less of the poisoned bait may be prepared by using the ingredients in less amounts. It should be remembered that strychnine is a deadly poison, and every precaution should be taken to avoid danger to other animals or to human beings.

A field to be planted in corn may be freed from gophers by the use of poison once or twice before corn-planting time. Seed corn

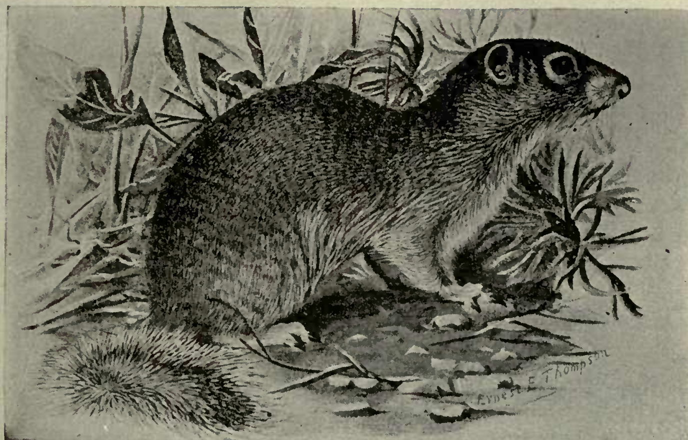

Fig. 409.—Gray ground squirrel or "gray gopher," *C. franklinii*. (After Merriam, U. S. D. A.)

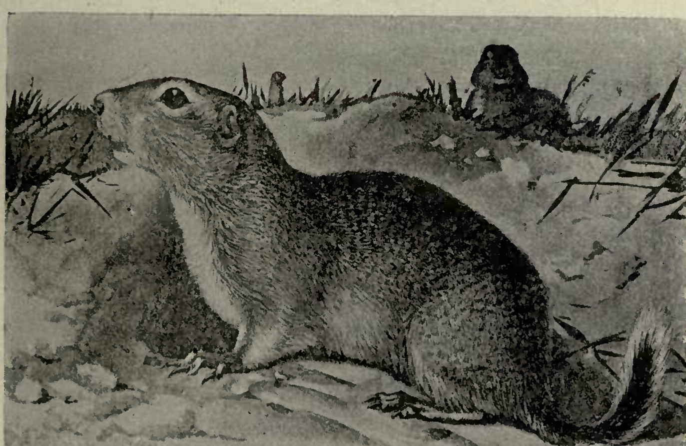

Fig. 410.—Another species of ground squirrel, *C. richardsonii*. (After Merriam, U. S. D. A.)

can be protected from their attack by various means. Soak corn in the strychnine solution mentioned above. Dry this and distribute it over the infested area. If gophers have not disappeared

at corn-planting time, the seed corn itself may be soaked in the strychnine solution for twenty-four hours without injury. This is perhaps the better way, as only the animals actually guilty of attacking the planted corn are killed, while if poisoned corn is distributed promiscuously valuable birds and innocent animals may suffer.

The common mole (Fig. 411) is usually not a pest, but a beneficial animal, feeding upon worms and the various insects which live in the ground. At times, however, it becomes a nuisance, on account of the presence of its mounds in large numbers in gardens and lawns. In spite of the fact that moles are largely insectivorous in their habits, they sometimes eat garden products

Fig. 411.—The common mole. (From Muller.)

which are below the surface of the ground and sometimes gnaw bulbs. It is believed that they occasionally eat newly planted corn and peas, and the writer has seen one in captivity eat every pea in an opened pod which was thrown into its cage.

Moles have few natural enemies. Even the common house cat, though she may occasionally catch a mole, disdains to eat it.

Trapping and Other Methods for the Mole.—We have but few, if any, records of successful attempts at poisoning moles. A friend, to rid his garden of moles, soaked some seed peas in a strychnia solution and placed them in the burrows. This resulted in immediately stopping the depredations of the animals. Fresh peas would furnish a more attractive bait. Soak them in a strychnia solution or wet them and roll them in powdered strychnine. Excellent results have been obtained by the use of a spear trap

(Fig. 412). This is set over the ridge made by a mole burrowing just beneath the surface in search of food. If this surface burrow is still in use, the trap hardly ever fails to catch the animal.

Moles work ordinarily in the early morning and late afternoon, and when the earth of a mound moves, indicating the addition of fresh material from below, a manure fork driven into the moving mass generally impales the animal; or a light charge of powder and shot is effective.

F. E. Wood, in "A Study of the Mammals of Champaign County, Illinois" (Bull. Ill. State Lab. Nat. Hist., vol. viii, 1910), states that moles are very sensitive to odors and may be driven away by placing naphthalin, moth-balls, carbon bisulfid, or formalin in and around their runs.

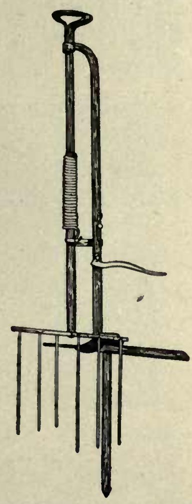

Fig. 412.—A successful mole trap.

Field mice (Fig. 413) destroy at least three million dollars' worth of crops in the United States every year. During the last few years farm losses have greatly increased through the work of these animals. Their extreme fecundity is emphasized by a published statement by D. E. Lantz, based upon scientific observation, that "a single pair and their progeny in five seasons would amount to nearly one million individuals."

Field mice begin breeding in the spring, probably early in April in the North, and produce several litters of from four to eight each in a season. The period of gestation is about twenty days. Their round nests are found at the ends of very short burrows, under stumps or brush heaps, or even directly on the surface of the ground, fastened stoutly to surrounding stems. They seek concealment later under hay stacks, shocks of corn, and similar places. They do not hibernate, but continue their depredations during winter in their hiding places and under the protecting snow.

Doubtless the war of extermination carried on by man against hawks, owls, crows, skunks, foxes, weasels, and snakes, all natural enemies of mice, is to a large extent responsible for present-day losses through the work of field mice. Other enemies of these mice are wolves, raccoons, bitterns, and herons. Perhaps the most effective way to keep down the numbers of field mice is to

protect, instead of slay, the various animals which prey upon them and hence are beneficial, though frequently referred to as "vermin."

Injuries caused by field mice are: Gnawing of orchard and nursery trees and shrubbery close to or just beneath the surface of the ground, usually during the winter season; the destruction of various kinds of grain at harvest time; and occasional depredations in houses and barns into which they have gained entrance.

In one case a very large per cent of young maple trees on three hundred acres were killed by mice, the injury being discovered after the snow had gone off. The owner of this tract began afterward to poison the offenders. Probably the injury to maples just referred to is, in part, due to the killing off of birds of prey and

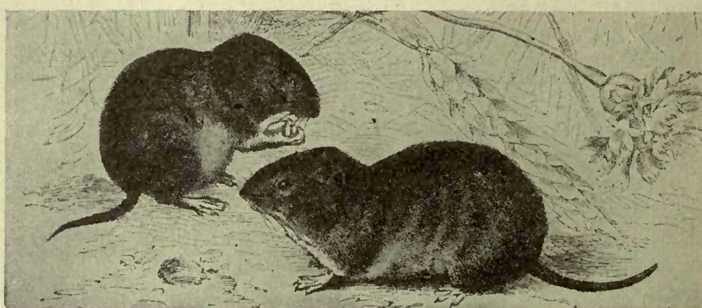

Fig. 413.—Field mice. (From Brehm.)

four-footed animals that feed upon mice. It seems to be a commonly accepted idea that all hawks and owls must be shot. They both work on field mice. Skunks and other small, four-footed animals that prey upon mice are mercilessly destroyed as being pests. It is by acts of this kind that the balance in nature is disturbed and unpleasant results follow.

Field mice are fond of wheat and rye, and injure timothy and clover. It has been estimated that one adult field mouse may consume, in one year, from twenty-four to thirty-six pounds of green vegetation. They have at least one redeeming trait, for they evidently eat a few insects, such as grasshoppers and beetles. However, the slight good they do in this way is far more than offset by their injurious work.

The work of mice in an orchard can easily be distinguished from that of rabbits. The latter gnaw higher up, and the marks

of their large incisor teeth are plainly visible. The finer markings of the small teeth of the mice can be seen in the wood from which they have removed the bark. As said before, they gnaw near or below the surface of the ground.

Mounding Injured Trees.—A tree of some size, badly injured by field mice, may frequently be saved, if the inner layer of bark has not been destroyed or seriously injured, by keeping a mound of earth over the injury until new bark is formed.

Protection Against Field Mice.—If the area is a small one, recourse may be had to small, inexpensive mouse-traps, such as sell for five cents each or less. A very good method of baiting these traps is to smear the pan with bacon fat and then dust it with oatmeal.

Early mulching of fruit trees should be avoided. Mulching should be done after the beginning of cold weather, if at all. Cover crops, such as buckwheat, oats, and clover, and trash of any kind harbor mice and render injury likely. An orchard in sod is more likely to be injured than a cultivated one.

The snow about the fruit trees should be tramped down occasionally during the winter to keep the mice from working under it.

Guards Against Mice.—Mechanical guards of approved pattern for use around trees are absolutely reliable. These are described under control of rabbits.

Washes to keep off Mice.—An application of a thick whitewash is a fair repellent for mice as well as rabbits. It is made by slaking quicklime in water, and rendered a deep blue by the addition of bluestone solution. It should be applied late in the fall, and the application should be repeated if possible on some warm day in winter, for the mixture should dry on the tree, not freeze on. To be effective against mice, it should be applied liberally to the trunk close to the ground. A brush or a spray pump with a nozzle adapted for whitewash can be used. Spraying the material in this way is preferable in treating shrubbery and rows of nursery trees. It is more rapid and perhaps more thorough work. It must be borne in mind that after rain and weather have removed these washes from the trunks of trees the bark is again attractive to mice and rabbits.

Washes containing blood or grease should not be used upon trees, as these are attractive to mice.

Poisoning mice is probably the most effective way of ridding a field of them, but care should be taken to prevent birds, poultry,

or other animals from being killed. Early spring, before the breeding season, is the best time for poisoning. Hundreds of field mice have been killed by poisoned bait placed in frequented locations. Of all the poisons, strychnine is the best. The solution recommended is the following: One ounce of sulfate of strychnia dissolved in a pint of boiling water. Boil until all the crystals are dissolved. Add an equal quantity of sugar syrup and mix well; a little oil of anise may well be added to make it more attractive. This quantity is sufficient to poison half a bushel of wheat or corn. It is advisable, but not absolutely necessary, to use cracked or crushed grain, since it absorbs the poison better than the uncrushed kernels. This poisoned grain should be allowed to dry. Instead of grain, a poisoned dough made of oatmeal can be made for immediate use.

Poisoned wheat has been used at the base of fruit trees with telling effect, and the same bait might also be placed along nursery rows. Poisoned grain or other poisoned bait should be placed in protected situations, as under boards, raised an inch from the ground, in burrows, or in tile. This is to prevent birds, poultry, or domestic animals from obtaining it. Strychnine is a deadly poison, and the greatest care should be observed to prevent accidents not only with the crystals but with the solution, the utensils used, and the bait itself.

Fumigation for these pests does not appear to be successful.

Cultivation to Control Field Mice.—In general, mice will be less numerous if neighboring swampy areas are drained, and if thorough plowing and harrowing are resorted to in cultivating crops. This discourages the growth of weeds of all kinds. The longer clover fields and other fields are left undisturbed, the more likely are mice to increase.

Destroying Field Mice by Burning.—Large numbers of field mice have been destroyed by burning fields infested with these animals. In all probability, a large proportion of the adults may escape the burning; but hundreds of nests scorched on the outside contain young, which can be quickly killed after the fire.

Rats and Mice About the House and Other Farm Buildings.—House mice can generally be controlled easily with small and inexpensive traps. Rats, on the other hand, become wary after a few have been killed in this way, and tax one's skill and ingenuity to the utmost.

The Brown or Norway rat, which is now the common house

rat in North America, is at times not only a veritable pest, but, on account of its harboring fleas and of its migratory habits, is a serious menace to health, as it spreads infectious diseases.

Extermination of Rats.—1. Scatter freshly slaked lime in rat holes and along rat runways.

2. Shoot an English sparrow and put it under a board in a place frequented by rats. If it is eaten, do the same thing a second time; then put strychnine, with a small knife, in the heart muscles of a third sparrow and put this in the same place.

3. Throw common green copperas about rat holes and along the runways.

4. Dust dry calomel on beef scraps and leave these where rats are common. Chickens and cats should be kept away from such poisoned scraps.

5. Dust dry concentrated lye on molasses in a shallow tin pan and leave this where rats run. Care should be taken to keep this, also, from other animals.

6. Feed the rats several days with a mixture of three parts flour and one part sugar. Then change to three parts flour, one part plaster of Paris, and one part sugar.

7. Mix bran, flour, sugar, white arsenic, and baking powder. Bake until crisp, and crumble near their holes.

8. It is said that the presence of carbolineum—a wood preservative containing zinc chloride—will drive away rats.

9. A poison paste may be made by mixing one part of barium carbonate (barytes), ground fine, and four parts cornmeal and adding sweet oil.

10. Mix four ounces of calomel (poison) with one quart or two pounds of any food which tempts rats or mice. Always season with sugar. Place where rats and mice run. It is well to cover it, leaving an aperture large enough for rats. Keep water out of their reach.

11. There are various good traps, and pieces of young rats make good bait.

General Suggestions for the Control of Rats.—Make the foundations of all farm buildings rat-proof. This naturally includes the screening of all basement windows.

Corn-cribs may be screened entirely with half-inch-mesh, galvanized netting. This will keep out sparrows as well as rats and mice.

Garbage should be kept in closed receptacles until carried

away. The proper disposal of the waste of country slaughter-houses should be regulated by law.

A ditch about eighteen inches deep, with perpendicular sides, dug about an infested area, has been utilized with good results. The mice fall in and may be killed before they can get out.

Some forms of virus are used to start diseases among mice, but with very indifferent success.

Fairly good results may be obtained by changing traps. That is, after one trap has lost its efficiency because the rats have become familiar with it, more may be captured by substituting another style of trap which has been proved effective.

A fairly good trap for warehouses, store-rooms, elevators, and the like, where rats congregate in large numbers, can be improvised from an empty iron can or tank with straight and fairly high sides. Place meal or grain in the bottom of such a receptacle, with boards, leading from the floor to the top, and from the top to the meal or grain inside, thus allowing the rats to pass in and out freely. After they have become accustomed to this, remove the boards from the inside. This allows them to enter, but prevents their escape.

Suggestions from the United States Department of Agriculture.—Bulletin 369 treats upon destroying rats and makes the following suggestions:

1. Greater cleanliness about stables, markets, grocery stores, warehouses, courts, alleys, and vacant lots in cities and villages, and like care on farms and suburban premises. This includes the storage of waste and garbage in tightly covered vessels and the prompt disposal of it each day.

2. Care in the construction of buildings and drains, so as not to provide entrance and retreats for rats, and the permanent closing of all rat holes in old houses and cellars.

3. The early threshing and marketing of grains on farms, so that stacks and mows shall not furnish harborage and food for rats.

4. Removal of outlying straw stacks and piles of trash that harbor rats in the fields.

5. The systematic destruction of rats, whenever and wherever possible, by (a) trapping, (b) poisoning, and (c) organized hunts.

6. The organization of rat clubs and other societies for systematic warfare against rats.

The Woodchuck, Marmot, or Ground Hog.—This animal is an inhabitant of most farms and is frequently a serious offender.

Clover and alfalfa suffer, as do many of the vegetables in the kitchen garden. Woodchucks in northern latitudes are dormant during winter, emerging from their burrows in late spring, though sometimes seen at the surface near their holes early in February, giving rise to the expression of "ground-hog day." They are heavy, thick-set animals, brown, black, gray, or yellowish gray; about two feet long from the tip of the nose to the end of the bushy tail. They are familiar to almost every farmer (Fig. 414).

Their natural enemies are not numerous. Dogs and foxes frequently dig them out of their burrows. Wolves, lynx, and the larger hawks and owls prey upon the young animals. Woodchucks are by no means nocturnal and are frequently seen feeding or

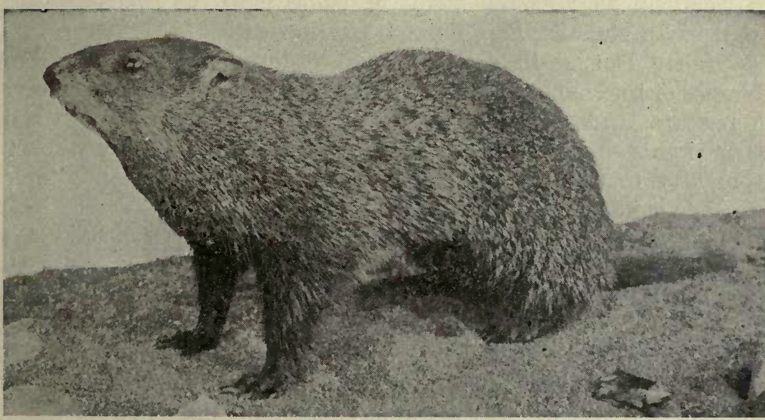

FIG. 414.—Woodchuck.

sunning themselves in the daytime. If cornered they put up a brave fight. Woodchuck oil is valued by some, and the flesh has been used as human food, but otherwise the animals possess no attractive virtues.

Controlling Ground Hogs.—1. They readily fall victims to steel traps placed in the mouths of their burrows. The trap should be placed a short distance down the burrow, in a depression, and covered lightly with earth. The chain of the trap may be fastened to a stick outside. This is perhaps the most feasible and also the most effective way of disposing of ground hogs.

2. A good marksman with a rifle stationed where he can command a view of the field can generally kill them at long range.

3. Poisoned baits may be made of succulent roots at a time when more attractive green food is scarce. Thrust these down their burrows.

4. Place a charge of blasting powder with a long fuse attached as far as possible down the hole and fire it.

5. Wrap a mass of cotton or oakum or other absorbent material about a heavy stone. Saturate this with bisulfid of carbon. Roll the ball as far as possible down the hole and close all openings immediately.

6. To keep them from attacking the garden the following is temporarily effective: Tie a cord one foot above the ground outside rows of peas, or patches of other garden vegetables attractive to woodchucks. Fasten strips of white cloth to this one foot apart, with ends hanging down a few inches.

Prairie Dogs.—In some of our western states where large colonies of these animals occur considerable injury has been caused in pasture lands by their eating or rendering unfit for use the various grasses upon which cattle feed. Since colonies may cover from fifty to one hundred acres or more of pasture land, their presence is no small matter to the owner.

The common prairie dog (*Cynomys ludovicianus*) is a brownish animal about a foot long. The brown of the back is mixed with gray and black. The under parts are pale yellow. The tail is about three and one-half inches long.

Control of Prairie Dogs.—In the late fall these creatures can be killed by the use of poisoned grain (see page 428). Place this in their burrows, or, better, about one and one-half feet away from each burrow. When this latter practice is followed, stock must be excluded from the area treated. Two applications, with an interval of about eight days between them, should be made.

In the summer time, when plenty of green food is available, poisoned grain is rejected. At that time poisoned alfalfa has been used with only fair success. Thirty pounds of green alfalfa is chopped into short lengths. A poisoned solution is prepared by dissolving sulfate of strychnia in water; and the fresh-cut alfalfa is thoroughly sprinkled with this. Mix the poison and bait in a metal tub which can be easily cleaned. This poisoned alfalfa should be sprinkled among the burrows at the close of the day to prevent its being dried by the hot sun. Stock, of course, must be excluded from the treated pasture.

The danger in the use of poison has been elsewhere commented

upon. Every precaution must be taken to keep such material away from children or adults ignorant of its qualities, as well as from animals for which it is not intended. Strychnine taken internally by man or animal is almost instantly fatal.

The Red Fox.—This animal and its varieties, the cross fox, silver fox, and black fox, now valuable for their fur, are serious enemies to poultry-raising in the less settled portions of the country. This is largely on account of its cunning. The genus in the wild state is not so abundant as formerly. This is in part due to the growth of the fur-farming industry and in part to the persecution to which these animals have been subjected.

The red fox has been known to kill from four to a dozen or more chickens in one visit to a hen-house. As in the case of the weasel, however, the animal is not without certain redeeming qualities. It is, for example, an inveterate enemy of field mice, rabbits, and woodchucks.

Description.—It is a little more than three feet long, sometimes reaching a length of forty-four inches. Its general color is rusty red or golden yellow, legs dark, feet black, and some black on the back part of the ears, under parts, breast, and lower jaw white. The end of the bushy tail is black with white tip.

Habits.—They mate in early spring, and a pair with young (four to eight or nine in the litter) constitute a family, the male evidently not seeking another mate. A period of fifty-one days elapses between mating and the birth of the young. It is believed that the average life of a fox is from eight to ten years.

The writer once owned a red female fox which was kept near the house, in the orchard, fastened by a long chain and furnished with an overturned box for a retreat in bad weather or at other times. She was playful in the extreme and gentle as a kitten when in the mood, but if not disposed to romp, depressed ears and opened jaws which could close with lightning rapidity constituted sufficient warning to leave her alone. If approached when eating she would first snarl at the intruder, and if that were not sufficient and one continued to approach, she would defile her food and walk away. It is known that a fox will, under certain conditions, make friends with dogs, perhaps for reasons of self-preservation. This may have been the case with the above-mentioned animal, for frequently fox hounds from a neighbor's yard would gather in the orchard where this animal was chained and evidently indulge in a fox "chase," much to the disgust of members of the family

who slept or endeavored to sleep on that side of the house next the animals. The fox was never injured by the dogs.

Control.—Skilful methods of trapping, calling for most painstaking efforts, are the only means of defense on the part of the poultry raiser. Poultry yards of modern construction reduce the danger of attack.

The Weasel.—Various species of weasel occur in different parts of the United States. All are wantonly destructive to animal life, as many a poultry raiser will attest. An entire flock of poultry may be destroyed by a weasel in a single night. Weasels also are persistent robbers of birds' nests. On the other hand, they eat white-footed mice and meadow mice, the latter animals being pests to horticulture. Weasels are fond of rats and mice found about farm buildings, and are enemies of rabbits. Northern varieties turn white in winter, the tip of the tail alone remaining black as in summer.

Loose stone walls, piles of stone, stumps, hollow trunks of trees or burrows formerly occupied by other animals, are favored retreats for the weasel.

About forty days are given as the period between mating and the birth of the young, a litter numbering about four to eight.

As in the case of the fox, trapping and modern buildings appear to be the best methods of defense available to the poultry raiser.

The red squirrel is, in its varied forms, widely distributed over the entire United States. It is an acknowledged pest indirectly on account of its habit of preying upon eggs and young of birds, most of which are useful to the farmer and orchardist. It also reduces the yield of pine seed by cutting off and burying the green cones. Maples suffer in the spring from the attacks of red squirrels, which gnaw holes in the upper side of larger branches and drink the sap gathering therein. Trappers complain that the red squirrel frequently steals bait from their traps. Evidence is not lacking that the gray squirrel and its varieties are also, to some extent, guilty of robbing birds' nests, yet they are not so persistent in this habit, or so destructive as the red squirrel, and in most localities they are much less common than the latter variety.

The Common Skunk.—There are nine known species of skunks, but the data given are for the most common and well-known genus (*Mephitis*), and are practically applicable to all known North American species.

Contrary to the general belief, skunks are, on the whole, useful to the farmer. They eat grasshoppers, tobacco worms, army worms, white grubs, potato beetles, and other insects; they also feed on field mice, young rabbits, chipmunks, etc. They may occasionally take bees, which depredation the bee-keeper can easily prevent by having his hives sufficiently high above the ground.

In times of scarcity of other food, individual skunks may acquire the habit of eating poultry; but a skunk can reach only a fowl that is roosting on or near the ground, or a setting hen close to the ground. Only one fowl is killed at a time. The ordinary steel trap affords an easy means of capturing an animal which has this habit.

The fact is now recognized by scientists that skunks are useful to the farmer. Acknowledgment of this usefulness is shown in the enactment of state laws protecting skunks. The adaptability of the animals to fur-farming projects places them on a very valuable footing.

The Raccoon.—This clumsy animal has a gray coat and bushy tail, the latter barred with black. It weighs from ten to twenty pounds or more. It has a wide range over the entire United States. In the North in severe winter weather it hibernates, coming out from its retreat on warm days. In the southern states there is no hibernation. In Florida there occurs a more yellowish form.

The raccoon prefers a retreat among rocks or a hollow tree for its residence. It is frequently injurious to corn when in the milk stage, wantonly destroying much more than it needs. It also feeds upon insects, grapes, berries, nuts, crawfish, and occasionally catches fish swimming in shallow streams. It also preys upon ground-nesting birds, and even robs the nests of birds and squirrels in trees. The peculiarity which gave it its scientific name, *lotor*, which means "a washer," consists in its always washing meat before eating it. The young are born in April and May, four being the number in the usual litter.

Negroes in the southern states delight in "coon" hunts, and the animal is easily trapped. The flesh is used for human food, having a resemblance to fat pork. There is much demand for the fur of the raccoon. It may be said that the annual kill of raccoons in North America amounts to something like four million individuals.

QUESTIONS

1. Give life history of hares and rabbits.
2. Enumerate injuries caused by the cottontail rabbit and give methods of prevention.
3. Describe the habits of pocket gophers and the construction of their burrows. What methods are advised for extermination?
4. Describe the habits of the common mole, and the kinds of food it uses.
5. What economic bearing has the presence of birds of prey and weasels, foxes, and skunks on field mice?
6. For what injurious work are field mice responsible and how are they controlled?
7. What methods are advocated for lessening depredations of house rats and house mice?
8. Give life history, habits, and methods of control of the ground squirrels.
9. Describe habits of prairie dogs and their control.
10. Give methods for controlling woodchuck injury.
11. Describe habits of the common skunk, and tell of its relation to agriculture.
12. When are litters of young produced, and how many in a litter in the case of the cottontail rabbit, the pocket gopher, the so-called "thirteen-lined gopher," and field mice?
13. What damage is charged to the red squirrel?
14. Why should raccoons be killed?
15. What observations have you made, or what experiences have you had with four-footed pest of the farm.

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